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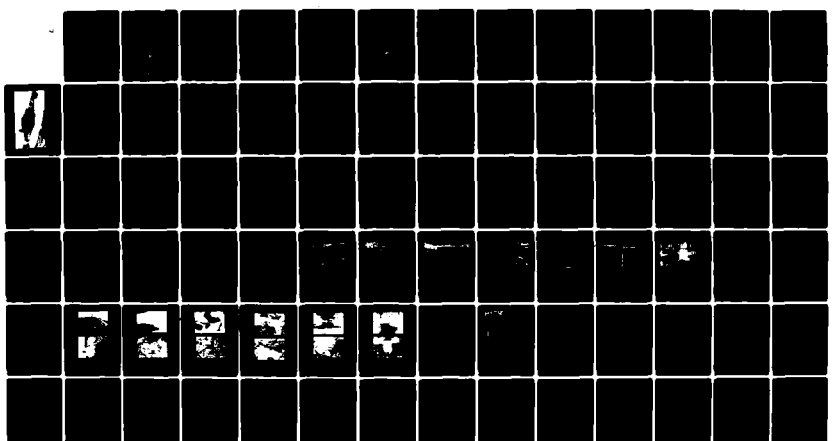

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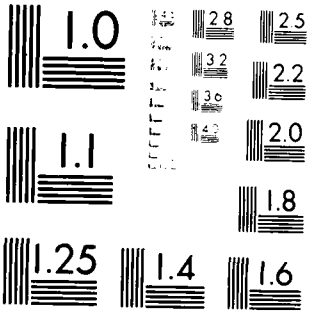

HOUSATONIC RIVER BASIN

BETHEL, CONNECTICUT

CHESTNUT RIDGE RESERVOIR DAM
CT 00075

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

DEPARTMENT OF THE ARMY

NEW ENGLAND DIVISION, CORPS OF ENGINEERS

WALTHAM, MASS. 02154

AUGUST, 1979

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19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

DAMS, INSPECTION, DAM SAFETY,

Housatonic River Basin
Bethel, Conn.
Chestnut Ridge Reservoir Dam

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The project, built in 1910, consists of an earthfill dam and a seperate earthfill dike with a spillway near its center. The 256± foot high dam and the 80± foot long, 5± ft. high dike are similar in construction, with 10 to 12 foot wide crests and upstream and downstream slope inclinations of 2± horizontal to 1 vertical. Upstream slope protection consists of hand-placed riprap. At the toe of the dam is a dry laid stone retaining wall. The spillway is a 22 foot long concrete sill with stop planks and masonry training walls. The outlet works consist of a gatehouse with high and low level intakes to a 16 inch water supply main. The gate valve is operable.

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DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02154

REPLY TO
ATTENTION OF:
NEDED

NOV 29 1979

Honorable Ella T. Grasso
Governor of the State of Connecticut
State Capitol
Hartford, Connecticut 06115

Dear Governor Grasso:

Inclosed is a copy of the Chestnut Ridge Reservoir Dam Phase I Inspection Report, which was prepared under the National Program for Inspection of Non-Federal Dams. This report is presented for your use and is based upon a visual inspection, a review of the past performance and a brief hydrological study of the dam. A brief assessment is included at the beginning of the report. I have approved the report and support the findings and recommendations described in Section 7 and ask that you keep me informed of the actions taken to implement them. This follow-up action is a vitally important part of this program.

A copy of this report has been forwarded to the Department of Environmental Protection, the cooperating agency for the State of Connecticut. In addition, a copy of the report has also been furnished the owner, the town of Bethal.

Copies of this report will be made available to the public, upon request, by this office under the Freedom of Information Act. In the case of this report the release date will be thirty days from the date of this letter.

I wish to take this opportunity to thank you and the Department of Environmental Protection for your cooperation in carrying out this program.

Sincerely,

MAX B. SCHEIDER
Colonel, Corps of Engineers
Division Engineer

Incl
As stated

HOUSATONIC RIVER BASIN

BETHEL, CONNECTICUT

CHESTNUT RIDGE RESERVOIR DAM
CT 00075

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS. 02154

AUGUST, 1979

BRIEF ASSESSMENT

PHASE I INSPECTION REPORT

NATIONAL PROGRAM OF INSPECTION OF DAMS

Name:	CHESTNUT RIDGE RESERVOIR DAM
Inventory Number:	CT 00075
State Located:	CONNECTICUT
County Located:	FAIRFIELD
Town Located:	BETHEL
Stream:	TRIBUTARY TO SYMPAUG BROOK
Owner:	TOWN OF BETHEL
Date of Inspection:	AUGUST 2, 1979
Inspection Team:	PETER M. HEYNEN, P.E.
	MIRON PETROVSKY
	THEODORE STEVENS
	GEORGE BASSILAKIS, P.E.

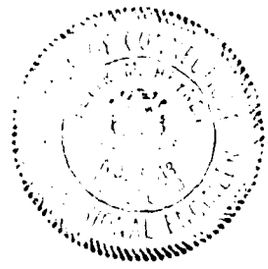
The project, built in 1910, consists of an earthfill dam and a seperate earthfill dike with a spillway near its center. The 256± foot long, 29± foot high dam and the 80± foot long, 5± feet high dike are similar in construction, with 10 to 12 foot wide crests and upstream and downstream slope inclinations of 2± horizontal to 1 vertical. Upstream slope protection consists of hand-placed riprap. At the toe of the dam is a dry-laid stone retaining wall. The spillway is a 22 foot long concrete sill with stop-planks and masonry training walls. The outlet works consist of a gatehouse with high and low level intakes to a 16 inch water supply main. The gate valve is operable.

Based upon the visual inspection and its past performance, the project is judged to be in fair condition. No evidence was observed of instability in any component of the project. There is substantial seepage through the dam; the retaining wall at the toe of the dam and the spillway training walls are in a state of disrepair and there is much vegetation on the dike and in the spillway approach and discharge channels.

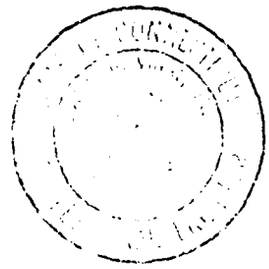
In accordance with Corps of Engineers Guidelines for the small size and high hazard classification of the dam, the test flood will be equivalent to the Probable Maximum Flood (PMF). Peak inflow to the reservoir is 1000 cubic feet per second (cfs); peak outflow is 730 cfs with the dam overtopped by 0.5 feet. With the stopplanks in place, the spillway capacity is 270 cfs, which is equivalent to 37% of the routed test flood outflow.

It is recommended that the owner retain the services of a registered professional engineer to perform a more detailed hydraulic/hydrologic analysis to determine the adequacy of the project discharge. Attention should also be focused on the seepage problems, rehabilitation of the stone retaining wall at the toe of the dam and the masonry training walls of the spillway and on improving maintenance and monitoring. Recommendations should be made by the engineer and implemented by the owner.

The above recommendations and any further remedial measures which are discussed in Section 7, should be instituted within one year of the owner's receipt of this report.



Peter M. Heynen, P.E.
Project Manager
Cahn Engineers, Inc.



Edgar B. Vinal, Jr., P.E.
Senior Vice President
Cahn Engineers, Inc.

This Phase I Inspection Report on Chestnut Ridge Reservoir Dam has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgment and practice, and is hereby submitted for approval.

JOSEPH W. FINEGAN, JR., MEMBER
Water Control Branch
Engineering Division

CARNEY M. TERZIAN, MEMBER
Design Branch
Engineering Division

JOSEPH A. MCELROY, CHAIRMAN
Chief, NED Materials Testing Lab.
Foundations & Materials Branch
Engineering Division

APPROVAL RECOMMENDED:

JOE B. FRYAR
Chief, Engineering Division

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspection. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I Investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam would necessarily represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions will be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test Flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions there of. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as neccessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

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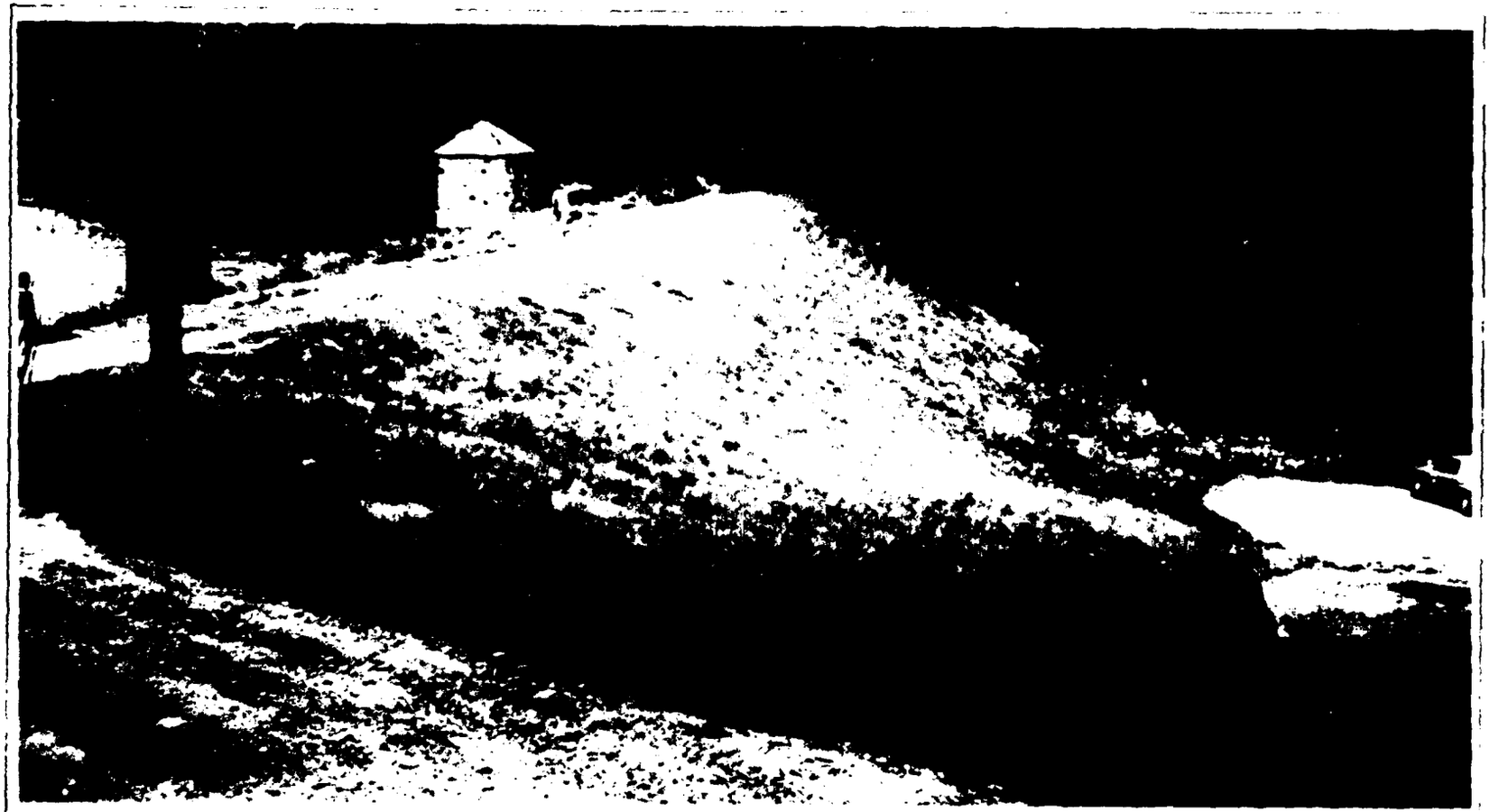

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(AUGUST 1979)

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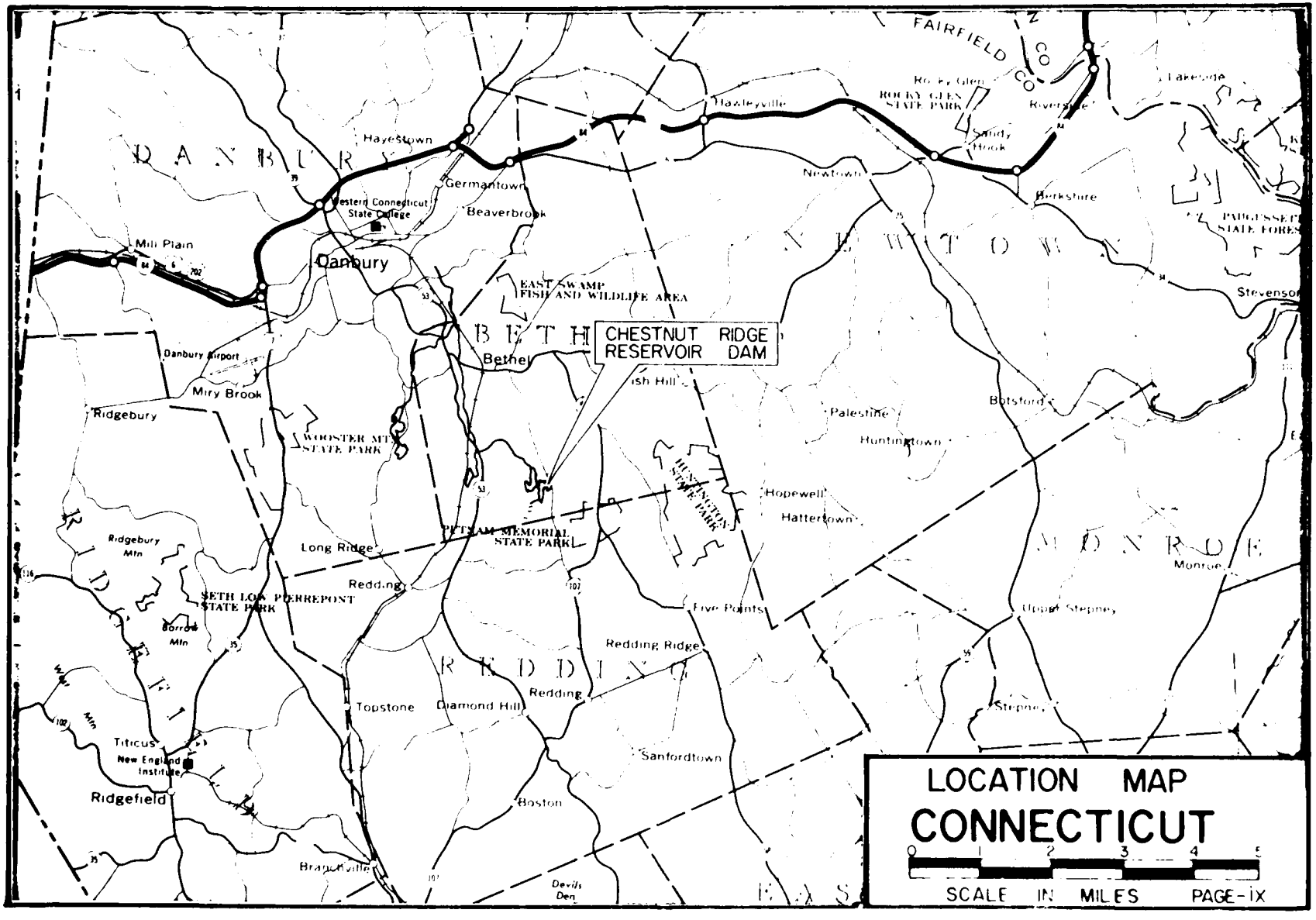

CHESTNUT RIDGE
RESERVOIR DAM
FAIRFIELD CO
DANBURY
NEWTOWN
BETHEL
REDDING
EASTON
Hayestown
Germantown
Beaverbrook
Haxleyville
Rocky Glen
ROCKY GLEN STATE PARK
Sandy Hook
Newtown
Lakeside
Riverside
Berkshire
Western Connecticut State College
Mill Plain
Danbury
EAST SWAMP FISH AND WILDLIFE AREA
Danbury Airport
Miry Brook
Ridgebury
WOOSTER MT. STATE PARK
Bethel
Palestine
Botsford
Huntingtown
Hopewell
Hattertown
PUTNAM MEMORIAL STATE PARK
Long Ridge
Redding
SETH LOW PIERREPONT STATE PARK
Ridgebury Mtn
Borrow Mtn
Five Points
Upper Stepney
Monroe
Redding Ridge
Topstone
Diamond Hill
Titicus
New England Institute
Ridgefield
Sanfordtown
Boston
Branchville
Devils Den
Stepney
LOCATION MAP
CONNECTICUT
0 1 2 3 4 5
SCALE IN MILES

PHASE I INSPECTION REPORT

CHESTNUT RIDGE RESERVOIR DAM

SECTION I - PROJECT INFORMATION

1.1 GENERAL

a. Authority - Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a National Program of Dam Inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. Cahn Engineers, Inc. has been retained by the New England Division to inspect and report on selected dams in the State of Connecticut. Authorization and notice to proceed were issued to Cahn Engineers, Inc. under a letter of November 28, 1978 from Max B. Scheider, Colonel, Corps of Engineers. Contract No. 33-79-C-0014 has been assigned by the Corps of Engineers for this work.

b. Purpose of Inspection Program - The purposes of the program are to:

1. Perform technical inspection and evaluation of non-federal dams to identify conditions requiring correction in a timely manner by non-federal interests.

2. Encourage and prepare the States to quickly initiate effective dam inspection programs for non-federal dam.

3. To update, verify and complete the National Inventory of Dams.

c. Scope of Inspection Program - The scope of this Phase I inspection report includes:

1. Gathering, reviewing and presenting all available data as can be obtained from the owners, previous owners, the state and other associated parties.

2. A field inspection of the facility detailing the visual condition of the dam, embankments and appurtenant structures.

3. Computations concerning the hydraulics and hydrology of the facility and its relationship to the calculated flood through the existing spillway.

4. An assessment of the condition of the facility and corrective measures required.

It should be noted that this report does not pass judgement on the safety or stability of the dam other than on a visual basis. The inspection is to identify those features of the dam which need corrective action and/or further study.

1.2 DESCRIPTION OF PROJECT

a. Location - The project is located on a tributary to Sympaug Brook in a rural area of the Town of Bethel, County of Fairfield, State of Connecticut and is shown on the Bethel USGS Quadrangle Map having coordinates latitude N 41°21' and longitude W 73°24.1'.

b. Description of Dam and Appurtenances - The entire project is divided into two portions; a 29 foot high earthfill dam across the stream and a five foot high earthfill dike aproximately 100 feet to the west of the dam. A 22 foot wide masonry spillway section is located near the center of the dike which is separated from the dam by a small knoll. The dam and dike appear to be similar in construction, both having upstream and downstream inclinations of 2 horizontal to 1 vertical and crest widths of 10 to 12 feet. There is a 65 foot long, 2 foot tall, 3 foot wide dry-land stone retaining wall at the toe of the dam. Hand-placed riprap on the upstream slopes extends to within approximately three feet of the common crest elevation. The spillway consists of a low concrete sill with stone masonry training walls and a 3 foot wide stone masonry dividing pier at the center of the sill. There are two 11 foot long stopplanks fitted atop the concrete sill, the stopplank to the right of the dividing pier is 1.3 feet in height while the left one is 0.7 foot high (Sheet B-1). It is not known upon what the dam, dike and spillway are founded, nor is it known if the dam and dike contain corewalls. A concrete and stone masonry gatehouse located approximately 15 feet off-shore near the left end of the dam houses high and low level intakes to a 16 inch water supply main which feeds an 8 inch main to a chlorination house located near the toe of the dam.

c. Size Classification - (SMALL) - The project impounds 290 acre-feet of water with the reservoir level at the top of the 29 foot high dam. According to the Recommended Guidelines, this dam is classified as small in size.

d. Hazard Classification (HIGH) - The dam is located approximately 1500 feet upstream of three homes on a small residential road and at elevations of only about two to five feet above the streambed. If the dam were to be breached, there is potential for loss of life and property damage at the impact area described above as well as at the chlorination house at the toe of the dam and further downstream at a residence on Nashville Road.

toe of the dam and further downstream at a residence on Nashville Road.

e. Ownership - Town of Bethel
Bethel Town Hall
Library Place
Bethel, Ct.
Office of the First Selectman
(203) 743-9231

f. Operator - Town of Bethel
Water Department
Mr. Lawrence Straiton, Superintendent
(203) 748-4411

g. Purpose of Dam - The dam impounds a water supply reservoir for the Town of Bethel.

h. Design and Construction History - Very little is known of the design and construction of the project other than what is written by Thomas M. Riddick, Consulting Engineer, New York City, in a 1947 report on the Bethel water works. Riddick writes:

> "Further sources were investigated, and in 1910 a dam was constructed at Wolf Swamp, impounding what is now known as Chestnut Ridge Reservoir. The contract was let to J. Boas for approximately $33,000, and included 5329 feet of pipe - principally 16" in size." (Appendix B-5).

There is no record of any changes to the dam, and it is therefore assumed that the dam was originally built to its present height and that no major alterations were performed on the dam since its construction in 1910.

i. Normal Operational Procedures - The outlet works at the gatehouse of the dam are very rarely, if ever, operated. Normally, the water supply lines are flowing, but if there is ever a need to shut off the flow, it is accomplished at valves located at the clorination house near the toe of the dam or further downstream in the water works system. There are no means for a rapid drawdown of the reservoir should the need arise.

1.3 PERTINENT DATA

a. Drainage Area - The drainage area is 0.4 square miles of largely undeveloped, rolling terrain.

b. Discharge at Damsite - Discharge from the reservoir is by the 16 inch pipe through the dam and at infrequent high reservoir levels over the spillway.

1. Outlet Works (Conduits):	One 16" pipe - invert el. not known
2. Maximum Known flood at damsite:	N/A
3. Ungated spillway capacity (stopplanks in place) @ top of dam el: 103.6	270 cfs.
4. Ungated spillway capacity (stopplanks in place) @ test flood el: 104.1	360 cfs.
5. Gated spillway capacity @ normal pool el:	N/A
6. Gated spillway capacity @ test flood el:	N/A
7. Total spillway capacity @ test flood el: 104.1	360 cfs.
8. Total project discharge @ test flood el: 104.1	730 cfs.

c. Elevations: No elevations were available for the project and no water surface elevation for the reservoir is shown on the U.S.G.S. Bethel Quadrangle Map. Therefore all elevations used throughout this report are referenced to the top of the concrete spillway sill which was arbitrarily set at elevation 100.

1. Streambed at centerline of dam:	74.6±
2. Maximum tailwater:	N/A
3. Upstream portal invert diversion tunnel:	N/A
4. Recreation pool:	N/A
5. Full flood control pool:	N/A
6. Spillway crest: right stopplank left stopplank	100.0 101.3 100.7
7. Design surcharge (original design):	N/A
8. Top of dam:	103.6

9. Test flood design surcharge:	104.1

d. Reservoir

1. Length of maximum pool:	1400± ft.
2. Length of recreation pool:	N/A ft.
3. Length of flood control pool:	N/A ft.

e. Storage

1. Recreation pool:	N/A acre-ft.
2. Flood control pool:	N/A acre-ft.
3. Spillway crest pool: (at top of stopplanks el. 101.3)	193 acre-ft.
4. Top of dam:	290 acre-ft.
5. Test flood pool:	300 acre-ft.

f. Reservoir Surface

1. Recreation pool:	N/A acres
2. Flood control pool:	N/A acres
3. Spillway crest:	32 acres
4. Test flood pool:	40± acres
5. Top of dam:	40± acres

g. Dam

1. Type	Dam and Dike are earthfill embankments
2. Length:	Dam: 256± ft. Dike: 80± ft. (Excluding spillway)
3. Height:	Dam: 29± ft. Dike: 5± ft.
4. Top width: (Both)	11± ft.
5. Side slopes: (Both)	2H to 1V Upstream 2H to 1V Downstream

6. Zoning;	N/A
7. Impervious Core:	Not Known
8. Cutoff:	N/A
9. Grout curtain:	N/A
10. Other:	Dry-laid stone retaining wall at toe of dam.

h. Diversion and Regulating Tunnel N/A

i. Spillway

1. Type:	Concrete sill with stopplanks. Masonry training walls
2. Length of weir:	22 ft.
3. Crest elevation:	Sill 100.0 Right Stopplank 101.3 Left Stopplank 100.7
4. Gates:	N/A
5. Upstream Channel:	Cut into natural ground
6. Downstream Channel:	Paved with hand-placed stone
7. General:	Upstream and downstream channels are overgrown.

j. Regulating Outlets The only regulating outlet is the water supply pipe near the left end of the dam.

1. Invert:	Not known
2. Size:	Size of intakes not known Pipe is 16" dia.
3. Description:	Not known
4. Control Mechanism:	Hand-cranked stand in water adjacent to gatehouse.
5. Other:	Flow normally controlled by valves in chlorination house.

SECTION 2: ENGINEERING DATA

2.1 DESIGN:

a. Available Data - The available data consists of the 1947 report on the Bethel Water Works by Thomas M. Riddick, a 1966 inspection report on the dam and photographs by A.M. McKenzie for the State of Connecticut, 1965 inventory data by the State of Connecticut and a 1973 inspection report by Victor F. Galgowski, of the Water and Related Resources Unit of the Connecticut Department of Environmental Protection.

b. Design Features - The available data indicates the design features stated previously in this report.

c. Design Data - There were no engineering values, test results or calculations available for the project construction.

2.2 CONSTRUCTION

a. Available Data - No information was available.

b. Construction Considerations - No information was available.

2.3 OPERATIONS

Reservoir level readings are taken daily. It is not known if the project spillway capacity has ever been exceeded. No formal operations records are known to exist.

2.4 EVALUATION

a. Availability - Existing data was provided by the Connecticut Department of Environmental Protection and by the operator. The operator made the facilities available for visual inspection.

b. Adequacy - The limited amount of detailed engineering data available was generally inadequate to perform an in-depth assessment of the dam, therefore, the final assessment of this dam must be based primarily on visual inspection, performance history, hydraulic computations of spillway capacity and approximate hydrologic judgement.

c. Validity - A comparison of records data and visual observation reveals no observable significant discrepancies in the record data.

SECTION 3: VISUAL INSPECTION

3.1 FINDINGS

a. General - The general condition of the project is fair. Inspection did reveal several areas requiring attention, maintenance and monitoring. The reservoir level was 4.6 feet below the crest of the embankment at the time of our inspection.

b. Dam - The project consists of an earthfill dam embankment and a nearby earthfill dike which includes the spillway.

Main Dam Embankment - The dam embankment is 256± feet long, 29± feet high and 12 feet wide at the top with upstream and downstream slope inclinations of approximately 2 horizontal to 1 vertical. The upstream slope is riprapped.

Crest - The crest is grass covered and inclined to downstream with a grade of 24± horizontal to 1 vertical. No misalignment or cracks were observed, however vehicle ruts were noted on the crest (Photo 1). A depression approximately 0.5± feet in depth and 10± feet in length was identified at the left end of the crest.

Upstream Slope - The riprap is in a fair condition with some stone displacement. Riprap extends to within 3± feet of the crest while the remainder of the slope above the riprap is brush covered.

Downstream Slope - The major portion of the downstream slope is protected by well-maintained grass cover and no misalignments or cracks were observed on this area of the slope. There is an extensive very wet and swampy area of the slope adjacent to the stone retaining wall (Photo 3 and Sheet B-1). The slope inclination of this area lessened considerably to approximately 10 horizontal to 1 vertical.

The dry-laid stone retaining wall at the toe of the dam is in fair condition (Photo 4). Many of the open joints between the stones of the wall were observed to be wet. Some stones were displaced and/or weathered.

Downstream of the retaining wall is a swampy area overgrown with various kinds of vegetation. On the right side of the area a small seepage stream was observed to be carrying a flow of 0.1 to 0.5 gallons per minute (gpm). A substantial seepage stream with discharge of 4 to 5 gpm was detected at the left side of the toe.

The left downstream abutment of the embankment is covered with considerable trees and brush (Photo 3). There is a depression approximately 1± foot deep and 6± feet wide extending from the top of the dam to the stone retaining wall. In this depression a seepage source with a measured flow rate of 3± gpm was discovered (Photo 5). The measured temperature of the water was 68°F and the conductivety was 70 micromhos. At the same time, the temperature and conductivety of reservoir water at a depth of 1 to 2 inches near the gatehouse were 85°F and 88 micromhos, respectively. Although the seepage source is located approximately 15 feet below the top of the dam, a wet condition along the abutment was observed extending to 5 to 6 feet above the seep. Brown silt deposits were observed in the stream below the source near the stone retaining wall (Photo 6).

Dike - The dike was entirely above water at the time of our inspection.

Crest - The crest is covered with heavy vegetation except for a 4 to 5 foot wide path (Photo 7). The crest appeared to be in fair condition. No misalignments, cracks or depressions were observed.

Upstream Slope - The upstream slope is overgrown with trees and brush (Photo 8). The separate areas of riprap observed through the dense vegetation were in fair condition.

Downstream Slope - The downstream slope was also overgrown. No seepage, wet areas, sloughing or erosion was observed.

Spillway - The spillway consists of an approach channel, a concrete sill weir, stone masonry training walls, a stone masonry dividing pier at the center of the weir and a discharge channel. Wood stopplanks atop the concrete sill are fitted into slots in the training walls and dividing pier (Photo 7).

The approach channel appeared to be cut into natural ground. Boulders, logs and brush were noted on the channel floor (Photos 8, 9 and 10).

The concrete sill of the spillway weir is in good condition. No cracking or spalling of the concrete sill was observed. The stopplanks on either side of the dividing pier were slightly different in height and a stopplank from the left part of the weir was laying on the ground (Photo 10). Obstructions upstream of the stopplanks, such as stones, boulders and stumps were observed (Photo 10). The stone masonry dividing pier and training walls have open joints and some deteriorated stones below the top of the stopplanks. Undermining was observed in several locations at the bottom of the pier and walls (Photos 7 and 10).

The discharge channel floor, paved with hand-placed stone is covered with trees and brush. Vehicle ruts on the channel floor were also observed (Photo 11).

c. Appurtenant Structures - There is a gatehouse located approximately 15 feet off-shore near the left end of the dam. Reportedly the gatehouse contains high and low level intakes to a 16 inch water supply main.

The stone masonry walls and the concrete substructure of the gatehouse are in good condition. No cracking or spalling of the concrete or masonry was observed (Photo 12).

d. Reservoir Area - The shoreline surrounding the pond is heavily wooded and largely undeveloped.

e. Downstream Channel - The downstream channel is mostly undeveloped, steep-sided at the left bank and wooded to the initial impact area.

3.2 EVALUATION

Based upon the visual inspection, the project is assessed as being generally in fair condition. The following features which could influence the future condition and/or stability of the project were identified.

1. Extensive wet areas on the downstream slope of the dam, probably caused by a high seepage water table could cause a sloughing condition.

2. Further deterioration of the dry-laid stone retaining wall at the toe of the dam could result in reduction of the structural stability of the embankment.

3. The concentrated seepage source at the left downstream abutment of the dam has perhaps caused the existing depression in this area and in the future could lead to structural instability of the left abutment.

4. Cracking and leaching joints of the stone masonry spillway training walls and pier of the spillway weir as well as the undermining of them could lead to further deterioration of the spillway.

5. Heavy vegetation on the left downstream abutment of the dam and on the crest and slopes of the dike impede dam monitoring. The vegetation could cause increased seepage through the dam and could cause considerable damage if trees overturn during strong winds or hurricane conditions.

6. Presently, the gatehouse is accessable only by boat as there is no permanent foot bridge from the dam.

SECTION 4: OPERATIONAL PROCEDURES

4.1 REGULATING PROCEDURES

The Bethel Water Department is constantly drawing from the reservoir by means of the 16 inch pipe through the dam, however flow is not regulated at the dam, but rather farther downstream in the water works system. If it is required that the system be entirely shut-off, this is done at a location downstream of the toe of the dam, leaving the 16 inch pipe through the dam under a full head of water. Also, there are no provisions at the dam for a rapid drawdown of the reservoir in case of an emergency.

4.2 MAINTENANCE OF DAM

Grass on the dam is mowed regularly and the swampy wet areas at the toe of the dam are cut usually about once a year with a scythe. There are no maintenance procedures followed for the dike. The spillway stopplanks are replaced as needed.

4.3 MAINTENANCE OF OPERATING FACILITIES

The gate valve at the gatehouse is not used nor is it maintained. Maintenance of the operating facilities in the chlorination house at the toe of the dam is performed regularly.

4.4 DESCRIPTION OF ANY FORMAL WARNING SYSTEM IN EFFECT

No formal warning system in in effect.

4.5 EVALUATION

Maintenance procedures followed for spillway, spillway approach and discharge channels and upstream slope of the dam are in need of improvement. Operational procedures, though adequate for the normal operation of the Water Works System, do not include provisions for shutting off the water supply main at the gatehouse on the upstream side of the dam and do not allow for a rapid drawdown of the reservoir.

A formal program of operation and maintenance procedures should be implemented, including documentation to provide complete records for future reference. Also, a downstream warning system should be developed and implemented within the time-frame indicated in Section 7.1c.

SECTION 5: HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. General - The dam is basically a high storage, low spillage type project with the reservoir level only occasionally reaching the elevation of the top of the stopplanks. Peak outflow for a PMF storm for this small watershed will be on the order of 75% of the peak inflow.

b. Design Data - No computations were available for the original dam construction.

c. Experience Data - No information on serious problem situations arising at the dam was found and it does not appear that the dam has been overtopped.

d. Visual Observations - Partial blockage of the spillway during a large storm could easily occur as the spillway approach channel is overgrown, as is the spillway discharge channel which also might reduce the spillway capacity under such conditions.

e. Test Flood Analysis - The test flood for this high hazard small size dam is equivalent to the Probable Maximum Flood (PMF). Based upon "Preliminary Guidance for Estimating Maximum Probable Discharges", dated March, 1978, peak inflow to the reservoir is 1000 cfs (Appendix D-1); peak outflow is 730 cfs with the dam overtopped 0.5 feet (D-5). The spillway capacity, with stopplanks in place, is 270 cfs (D-4), which is approximately 37% of the routed test flood outflow. Under one-half PMF conditions, the peak inflow is 500 cfs (D-2); peak outflow is 270 cfs, with the flood pool at the top of the dam (D-5).

f. Dam Failure Analysis - Utilizing the April, 1978, "Rule of Thumb Guidance for Estimating Downstream Dam Failure Hydrographs", the peak failure outflow from the dam breaching would be 21,300 cfs (D-7). A breach of the dam would result in a rise of approximately 8.7 feet in the water level of the stream at the initial impact area, which corresponds to an increase in the water level from a depth of approximately 3.2 feet above the normal water surface just before the breach, to a depth of approximately eleven feet above the normal water surface just after the breach (D-7). The rapid 8.7 foot increase in the water level at the initial impact area would endanger three houses near the stream and approximately 2 to 5 feet above the normal stream elevation.

SECTION 6: STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations - The visual inspection did not reveal any indications of stability problems. There are extensive wet areas on the downstream slope and at the toe of the main embankment. A seepage source at the left downstream abutment of the embankment may have caused a depression along this abutment. The deteriorated stone retaining wall at the toe of the dam and the damaged masonry training walls of the spillway could endanger the future safety and stability of the dam.

b. Design and Construction Data - There is not enough design and construction data available to permit an in-depth analysis and assessment of the structural stability of the dam.

c. Operating Records - The operating records do not include any indications of dam instability since its construction in 1910.

d. Post Construction Changes - There are no records available concerning post-construction changes of the dam.

e. Seismic Stability - The dam is in Seismic Zone 1 and according to the Recommended Guidelines, need not be evaluated for seismic stability.

SECTION 7: ASSESSMENT, RECOMMENDATIONS AND REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Condition - Based upon the visual inspection of the site and its past performance, the project is in fair condition. No evidence of structural instability was observed in the dam and its appurtenances. The embankment is generally in fair condition with extensive wet areas on the downstream slope and at the toe and a concentrated seepage source in a depression at the left downstream abutment. Other areas of concern include the deteriorated dry-laid stone retaining wall of the embankment and the damaged masonry training walls of the spillway weir, the spillway capacity and the lack of scheduled maintenance.

Based upon "Preliminary Guidance for Estimating Maximum Probable Discharges" dated March, 1978, peak inflow to the reservoir is 1000 cfs; peak outflow is 730 cfs with the project overtopped by 0.5 feet. The spillway capacity, with stopplanks in place, is 270 cfs, which is equivalent to approximately 37% of the routed test flood outflow.

b. Adequacy of Information - The information available is such that an assessment of the condition and stability of the dam must be based on the visual inspection, past performance of the dam, and sound engineering judgement.

c. Urgency - It is recommended that the measures presented in Section 7.2 and 7.3 be implemented within one year of the owner's receipt of this report.

d. Need for Additional Information - There is a need for more information as recommended in Section 7.2.

7.2 RECOMMENDATIONS

It is recommended that further studies be made by a registered professional engineer qualified in dam design and inspection pertaining to the following:

1. More sophisticated flood routing should be undertaken to refine the test flood figures. A study should be undertaken to determine the spillway adequacy and potential for overtopping. Recommendations should be made by the engineer and implemented by the owner.

2. Inspection of the dam during times of high and low head to assess the seepage problems. He should also formulate and implement any necessary recommendations. Items of particular importance are as follows:

a. Evaluation of the embankment and the dike condition when the reservoir level is near or higher than the top of the stopplanks of the spillway weir (and the desirability of removing the stop-planks should be assessed). Installation of piezometers is desirable for determination of the water table in the body of the dam.

b. Investigation of the origin and significance of the wet areas on the downstream slope and at the toe of the dam and the seepage source at the left abutment of the dam.

c. Investigation of the origin and significance of the depression at the left end of the crest and abutment of the dam embankment. The depression should be filled and compacted with properly graded material to reduce the potential for overtopping and erosion during high reservoir levels.

d. Investigation of any possible influence of the 16 inch low-level outlet on changes in seepage at the left abutment of the dam due to possible cracks or corrosion in the outlet pipe.

3. Restoration of the stone retaining wall at the downstream slope of the dam taking into consideration the importance of this wall for stability of the dam.

4. Removal of the trees from the dam and dike crest and slopes, including the proper filling of the resulting holes.

5. Installation of an effective means of rapidly draining the reservoir in an emergency situation.

7.3 REMEDIAL MEASURES

a. Operation and Maintenance Procedures - The following measures should be undertaken by the owner within the time-frame indicated in Section 7.1c, and continued on a regular basis.

1. Round-the-clock surveillance should be provided during periods of unusually heavy precipitation and high project discharge. The owner should develop a downstream warning system to be used in case of emergencies at the dam.

2. A formal program of operation and maintenance procedures should be instituted and fully documented to provide accurate records for future reference. The operation and maintenance procedures should include provisions for shutting off the flow through the water supply main, if the need arises, at the gatehouse on the upstream side of the dam.

3. A program of inspection by a registered, professional engineer qualified in dam inspection should be instituted on an annual basis. The inspections should be comprehensive and technical in nature and should include the operation of the low-level outlet works.

4. The vehicle ruts on the crest of the dam should be repaired and paving for light vehicle use should be placed or vehicular traffic completely restricted.

5. The borders of the wet area on the downstream slope and seepage flow from source on the left abutment of the dam should be monitored periodically.

6. The deteriorated masonry training walls and masonry pier of the spillway weir should be repaired and undermining of the walls and pier should be repaired.

7. All obstructions on the floor and slopes of the spillway weir, approach and discharge channels, including boulders, logs, brush and trees should be removed.

8. Brush on the crest, slopes, toe and abutments of the dam and the dike should be removed. The grass on these areas of the dam should be mowed as part of routine dam maintenance.

9. Trespassing on the dam and surrounding land should be eliminated with strict prohibitive measures.

10. A permanent foot bridge should be constructed to provide access to the gatehouse.

7.4 ALTERNATIVES

This study has identified no practical alternatives to the above recommendations.

APPENDIX A

INSPECTION CHECKLIST

VISUAL INSPECTION CHECK LIST
PARTY ORGANIZATION

PROJECT Chestnut Ridge Reservoir Dam

DATE: August 2, 1979

TIME: 9am - 1pm

WEATHER: Sunny, 82°F

W.S. ELEV. 99± U.S. _____ DN.S

PARTY:	INITIALS:	DISCIPLINE:
1. Peter M. Heynen	PMH	Cahn Engineers Inc
2. Miron Petrovsky	MP	Cahn Engineers, Inc.
3. Theodore Stevens	TS	Cahn Engineers, Inc
4. George Bassilakis	GB	Cahn Engineers, Inc
5. Larry Straiton (Owner Representative)		Town of Bethel
6.		

PROJECT FEATURE	INSPECTED BY	REMARKS
1. Dam Embankment	PMH, MP, TS, JC, GB	
2. Dike	PMH, MP, TS, JC, GB	
3. Gatehouse	PMH, MP, TS, JC, GB	
4. Spillway	PMH, MP, TS, JC, GB	
5.		
6.		
7.		
8.		
9.		
10.		
11.		
12.		

PERIODIC INSPECTION CHECK LIST

PROJECT Chestnut Ridge Reservoir Dam DATE August 2, 1979

PROJECT FEATURE Dam Embankment BY PMH, MP, TS, GB

AREA EVALUATED	CONDITION
DAM EMBANKMENT	
Crest Elevation	103.6±
Current Pool Elevation	99.0±
Maximum Impoundment to Dat	Unknown
Surface Cracks	None observed
Pavement Condition	Grass, vehicle ruts
Movement or Settlement of Crest	None observed
Lateral Movement	
Vertical Alignment	Appears good
Horizontal Alignment	
Condition at Abutment and Concrete Structures	Depression on left abutment
Indications of Movement of Structural Items on Slopes	None observed
Trespassing on Slopes	Some
Sloughing or Erosion of Slopes or Abutments	depression on left end on d/s slope
Rock Slope Protection-Riprap Failures	some stone displacement on u/s slope
Unusual Movement or Cracking at or Near Toes	None observed
Unusual Embankment or Downstream Seepage	Seepage source on left abutment
Piping or Boils	None observed
Foundation Drainage Feature	N/A
Toe Drains	
Instrumentation System	

PERIODIC INSPECTION CHECK LIST

PROJECT Chestnut Ridge Reservoir Dam DATE August 2, 1979

PROJECT FEATURE Dike BY CMH, MP, TS, GB

AREA EVALUATED	CONDITION
DIKE EMBANKMENT	
Crest Elevation	103.6±
Current Pool Elevation	99.0±
Maximum Impoundment to Date	Unknown
Surface Cracks	None observed
Pavement Condition	Heavy brush & trees
Movement or Settlement of Crest	None observed
Lateral Movement	None observed
Vertical Alignment	Appears good
Horizontal Alignment	Appears good
Condition at Abutment and at Concrete Structures	Heavy brush & trees on abutments
Indications of Movement of Structural Items on Slopes	None observed
Sloughing or Erosion of Slopes or Abutments	None observed
Rock Slope Protection-Riprap Failures	Riprap on U/S slope, heavy brush
Unusual Movement or Cracking at or Near Toes	None observed
Unusual Embankment or Downstream Seepage	None observed
Piping or Boils	None observed
Foundation Drainage Features	N/A
Toe Drains	N/A
Instrumentation System	N/A
Trespassing on Slopes	Some

PERIODIC INSPECTION CHECK LIST

PROJECT Chestnut Ridge Reservoir Dam DATE August 2, 1979

PROJECT FEATURE Gatehouse BY PMH, MP, TS, GB

AREA EVALUATED	CONDITION
OUTLET WORKS-CONTROL TOWER	Stone masonry gatehouse on concrete substructure
a) Concrete and Structural	
General Condition	Good
Condition of Joints	None observed
Spalling	
Visible Reinforcing	
Rusting or Staining of Concrete	
Any Seepage or Efflorescence	
Joint Alignment	N/A
Unusual Seepage or Leaks in Gate Chamber	None observed
Cracks	
Rusting or Corrosion of Steel	
b) Mechanical and Electrical	
Air Vents	N/A
Float Wells	
Crane Hoist	
Elevator	
Hydraulic System	
Service Gates	16" gate valve, operable
Emergency Gates	N/A
Lightning Protection System	
Emergency Power System	
Wiring and Lighting System	

PERIODIC INSPECTION CHECK LIST

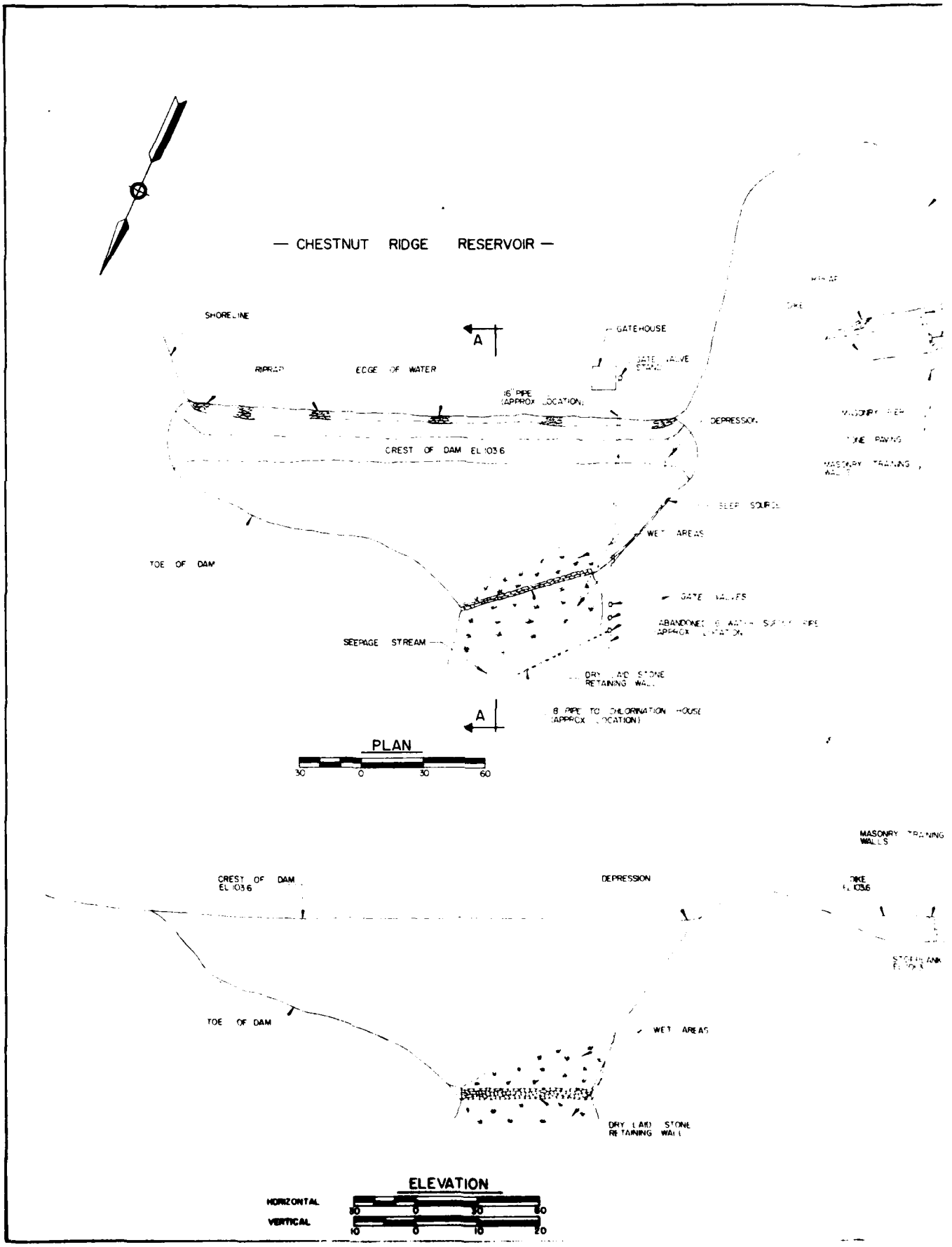
PROJECT Chestnut Ridge Reservoir Dam DATE August 2, 1979

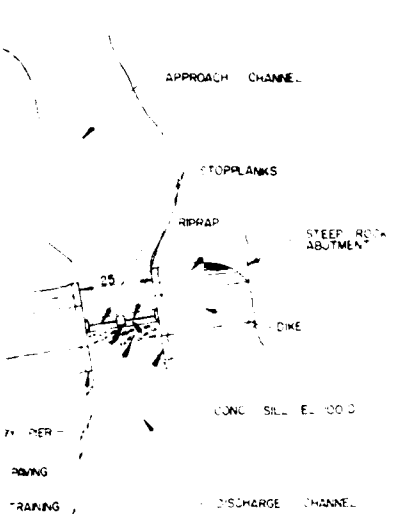
PROJECT FEATURE Spillway BY PA, MP, TS, GB

AREA EVALUATED	CONDITION
OUTLET WORKS-SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS	
a) Approach Channel	
General Condition	Fair to poor
Loose Rock Overhanging Channel	None observed
Trees Overhanging Channel	Some
Floor of Approach Channel	Boulders & brush
b) Weir and Training Walls	Conc slab w/stoop planks & stone masonry training walls
General Condition of Concrete	Concrete - good, train. walls - fair
Rust or Staining	None observed
Spalling	Some, train walls
Any Visible Reinforcing	None observed
Any Seepage of Efflorescence	None observed
Drain Holes	N/A
c) Discharge Channel	
General Condition	Fair
Loose Rock Overhanging Channel	None observed
Trees Overhanging Channel	Some
Floor of Channel	Trees & brush
Other Obstructions	None

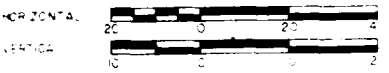
APPENDIX B

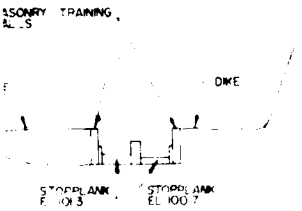
ENGINEERING DATA AND CORRESPONDENCE


— CHESTNUT RIDGE RESERVOIR —
SHORELINE
RIPRAP
EDGE OF WATER
A
GATEHOUSE
GATE VALVE
16" PIPE (APPROX LOCATION)
DEPRESSION
CREST OF DAM EL 1036
TOE OF DAM
SEEPAGE STREAM
WET AREAS
GATE VALVES
DRY LAID STONE RETAINING WALL
8" PIPE TO CHLORINATION HOUSE (APPROX LOCATION)
PLAN
30 0 30 60
MASONRY TRAINING WALLS
CREST OF DAM EL 1036
DEPRESSION
DIKE EL 1036
TOE OF DAM
WET AREAS
DRY LAID STONE RETAINING WALL
ELEVATION
HORIZONTAL
VERTICAL
60 0 30 60
10 0 10 20



SECTION A-A





NOTES

1. THIS PLAN WAS COMPILED FROM A CAHN ENGINEERS PRELIMINARY SURVEY OF THE DAM DATED AUGUST [illegible] 1979. DIMENSIONS SHOWN ARE APPROXIMATE. NOT ALL TOPOGRAPHIC AND HYDRAULIC FEATURES ARE NECESSARILY IDENTIFIED.

2. NO ELEVATIONS WERE AVAILABLE FOR THE DAM AND NO WATER SURFACE ELEVATION FOR THE RESERVOIR IS SHOWN ON THE USGS BETHEL QUADRANGLE MAP. THEREFORE ALL ELEVATIONS SHOWN ARE REFERENCED TO A BENCH MARK OF 100 SET AT THE CONCRETE SPILLWAY SILL.

CAHN ENGINEERS INC. WALLINGFORD, CONNECTICUT ENGINEER	U.S. ARMY ENGINEER DIV NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS

NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS

PLAN, ELEVATION & SECTION

CHESTNUT RIDGE RESERVOIR DAM

TR - SYMPAUG BROOK BETHEL, CONNECTICUT

DRAWN BY	CHECKED BY	APPROVED BY	SCALE AS NOTED	
MA	TS	PmH	DATE AUGUST 1979	SHEET 8-1

SUMMARY OF DATA AND CORRESPONDENCE

Date	To	From	Subject	Page
July, 1947	Water Department Bethel, Connecticut	Thomas M. Riddick Consulting Engineer New York City	"Report on Water Works" (excerpts pertinent to Chestnut Ridge Res. Dam)	B-2
March 4, 1965	Files	Water Resources Commission, Supervision of Dams	Inventory Data	B-5
April 25, 1966	Water Resources Commission State of Connecticut	A. M. McKenzie Civil Engineer	Dam Inspection Report (with 7 photographs)	B-6
May 2, 1973	Files	Victor F. Galgowski Supt. of Dam maintenance, Water and Related Resources	Dam Inspection Memorandum	B-14

[illegible]
BETHEL, CONNECTICUT

REPORT [illegible]

[illegible]

Frederick H. [illegible]
Thomas J. Mannion
Edgar C. Platt, Sr.

BOARD OF FINANCE

Harold D. Senior
E. Ambrose English
Frank Mannion
George F. Carroll
Neil Lamond
Andrew Weber

THOMAS M. RIDDICK
Consulting Engineer
369 East 149th Street
New York City

July, 1947

By 1901 the capacities of [illegible] and Mountain Pond Reservoirs were [illegible]. A contract was awarded to H. I. Andrews for the construction of [illegible] at Mountain Pond to further increase the [illegible] of this collection reservoir.

It became necessary [illegible] to provide water at sufficient pressure to supply Hoyt Hill and other areas [illegible] at a relatively [illegible]. An artesian well was drilled at a cost of approximately $1,200. This well failed to develop [illegible] as the location (on Hoyt Hill) was very poor since it had no appreciable drainage area.

Further sources were investigated, and in 1910 a dam was constructed at Wolf Swamp, impounding what is now known as Chestnut Ridge Reservoir. The contract was let to J. Boas for approximately $35,000, and included 5329 feet of pipe - principally 16" size.

Another pump was purchased in 1912, probably for use at Mountain Pond, when the elevation of this reservoir dropped below that of gravity flow.

The raw Chestnut Ridge Reservoir water has always been of poor physical and chemical quality. Color ranges from 50 to 100 ppm, and iron from about 0.4 to 1.0 ppm. In an attempt to improve the quality of this water, pressure filters were installed at the Chestnut Ridge Reservoir in 1913, at a cost of approximately $8,500.

two sections, one to house the chlorine cylinders, and the other for the chlorinator and face of flow recorder.

2. High Service System

A. Chestnut Ridge Reservoir

This reservoir has a drainage area of 0.61 square miles, of which 15 per cent is water surface. A dam provides 63 M.G. of storage and an average depth of 6 feet. Like Marcus Reservoir, this shallow depth fosters growths of algae and weeds, which sometimes impart a disagreeable taste and odor to the water. The average yield is estimated at 0.37 M.G.D., which is greater than consumption on the High Service District. The reservoir, therefore, is normally maintained at a high level.

The physical and chemical qualities of this water are very bad, due to high color, high iron, and low alkalinity. In the light of present knowledge it is doubtful that this source of supply should have been selected.

B. Chestnut Ridge Rapid Sand Filtration Plant

The poor quality of Chestnut Ridge water has always been a source of trouble. Pressure filters were installed three years after the dam was erected but they were not able to properly treat this water. They were replaced by a Rapid Sand Filtration Plant (present capacity 0.2 M.G.D.) in 1926, but since there was no electric power at the site,

No. BT - 10

WATER RESOURCES COMMISSION
SUPERVISION OF DAMS
INVENTORY DATA

Inventoried by WPS

Date 4 MARCH 1965

Name of Dam or Pond BETHEL RESERVOIR

Code No. H 41 8 ST 16 4 SY 29 U 1

Nearest Street Location NASHVILLE ROAD EXTENSION

Town BETHEL

U.S.G.S. Quad. BETHEL

Name of Stream UNNAMED

Owner TOWN OF BETHEL

Address BETHEL

Pond Used for WATER SUPPLY

Dimensions of Pond: Width 400 FEET Length 1600 FEET Area 16 ACRES

Total Length of Dam 200 FEET Length of Spillway 25 FEET

Location of Spillway WEST END OF DAM

Height of Pond Above Stream Bed 30 FEET

Height of Embankment Above Spillway 4 FEET

Type of Spillway Construction OVERFLOW CHANNEL

Type of Dike Construction EARTH, RIP-RAP ON UPSTREAM FACE

Downstream Conditions WOODS

Summary of File Data

Remarks

Would Failure Cause Damage? PROBABLY Class B

A. M. McKENZIE
CIVIL ENGINEER
M. AM. SOC. C. E.

HYDRAULICS
WATER SUPPLY
LAND DEVELOPMENT

1300 MAIN STREET
SOUTH MERIDEN, CONN.

APR 28 1966
ANSWERED
REFERRED
FILED

April 25, 1966.

Water Resources Commission,
State of Connecticut,
State Office Building,
Hartford, 15,
Connecticut.

Ref: Bethel Reservoir Dam, Town of Bethel.
Bethel Quad.

Gentlemen:

As instructed in your letter of March 16, I have inspected the above dam and submit the following report for your information.

Bethel Reservoir, a part of the water supply of the Town of Bethel, is just west of Chestnut Hill Road about 2,miles south of the town. The entrance road to the Dam is from Nashville Road.

The Dam is a straight, earth fill structure 270' long on top with a maximum height of about 30' near the center. The top is regular and level with an average width of 16' and the slopes of the embankment, both upstream and downstream are 2:1. The upstream face is well protected with stone rip-rap to about 1' above the spillway elevation. The top of the earth fill is about 3' above the spillway.

Approximately 100' west of the west end of the main dam is another section of earth fill 80' long on top in which there is a stone masonry spillway with a length of 22'. The spillway is divided into two sections - see photo #2 & #3 - one one half is a wood flashboard 14" high and on the other half is a flashboard 20" high. The earth fill of the spillway section is 4' to 5' high and is well protected with stone rip-rap on both slopes. The water suface at the present is about 3' below the spillway and, from appearances, there has been no water over the spillway for several years.

Toward the west end of the main dam there is a gate house a few feet upstream where the control gates for the line to the system are located. There is no visable waste line thru the dam. Just below the downstream toe of the main dam there is a building where the chlorinating apparatus is located.

The earth fill is covered with good sod and the entire project seems to be well maintained. There is some very slight seepage below the downstream toe but nothing of any consequence. It is not considered that there is any hazard, at all, involved here and only infrequent inspections should be necessary.

Yours very truly

A. M. McKenzie

anclos. 7 - photos.

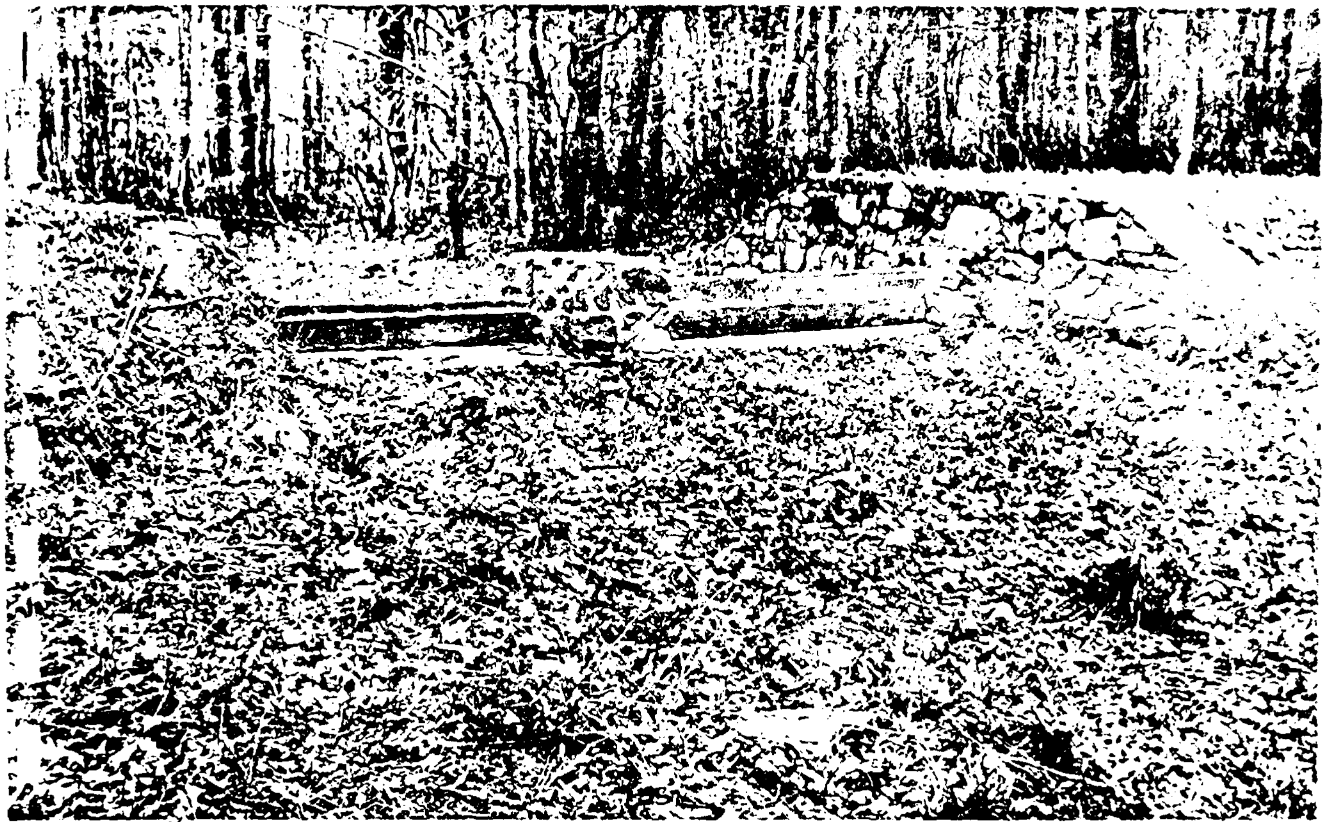


Photo #2

[illegible]

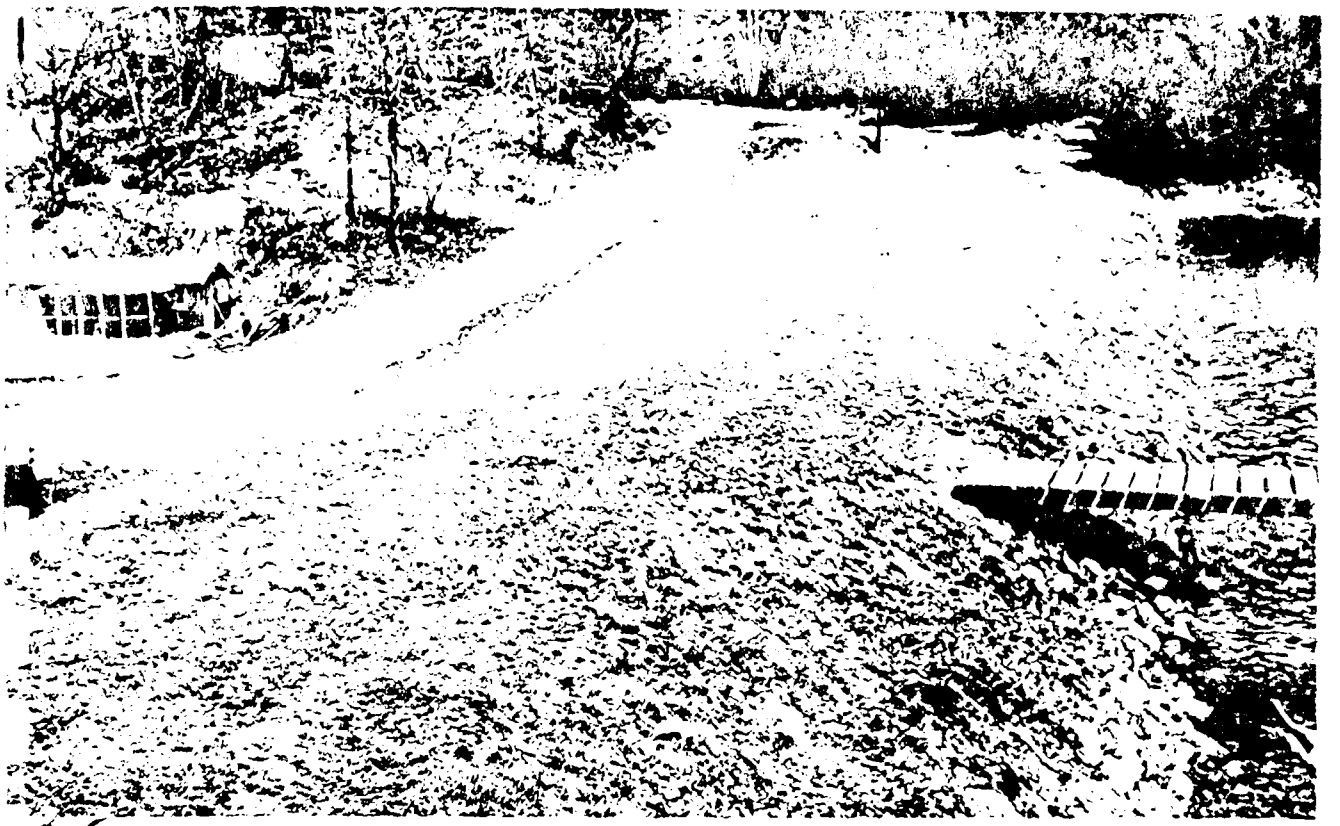
[illegible]
Town of Bethel
Bethel Quad.

Look downstream at spillway [illegible] and center portion of [illegible] in fair condition. Right flash [illegible] Left flash board is 12" - 4 [illegible] against right abutment.

#1

Bethel Reservoir Dam
Town of Bethel.

Looking at dam from [illegible]
Gate house at left.



4 1966

Bethel Reservoir Dam

Looking east over dam. Note erosion of rip-rap on water side which exists ± 1' above spillway elevation. Note line to gate house at right center.

Bethel Reservoir Dam

Look E over [illegible]
Entire slope is [illegible]
Note [illegible]

#9

[illegible] Reservoir Dam 4/[illegible]

Look ± north from top of dam. [illegible] house in foreground. The area to left of building is probably a covered reservoir.

...R DEPARTMENT MESSAGE
STO-200

SAVE TIME: *Handwritten messages are acceptable*
Use carbon if you really need a copy

TO: File	AGENCY: Water and Related Resources	DATE: 5/2/73
FROM: Victor F. Galgowski Supt. of Dam Maintenance	AGENCY: Water and Related Resources	TELEPHONE:
SUBJECT: Bethel Reservoir		

Subject dam inspected by the undersigned on 5/2/73. Seepage noted in center of dam - approximately 1 ' up from toe. Considerable clear flow along western downstream abutment. No problem. 15" flashboards in spillway. Water level within $\frac{1}{2}$" of top of flashboards.

Grass cover on downstream slope well maintained.

Dam appears safe.

Supt. of Dam Maintenance

VFG:

SAVE TIME: *If convenient, handwrite reply to sender on this same sheet.*

APPENDIX C

DETAIL PHOTOGRAPHS

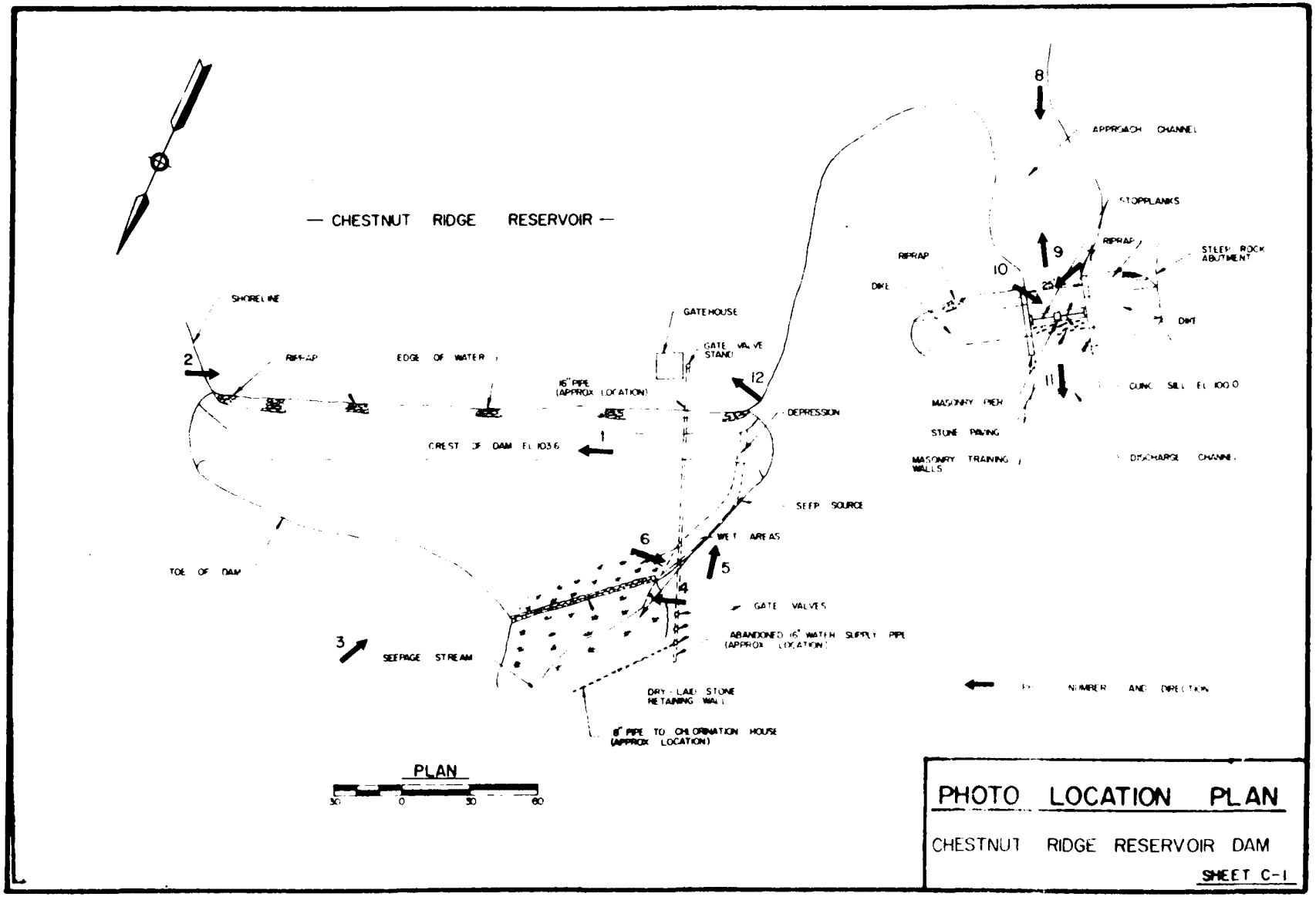


PHOTO LOCATION PLAN

CHESTNUT RIDGE RESERVOIR DAM

SHEET C-1

Photo 1 - [illegible] of embankment. Note vehicle ruts in the crest. (Aug. 79)

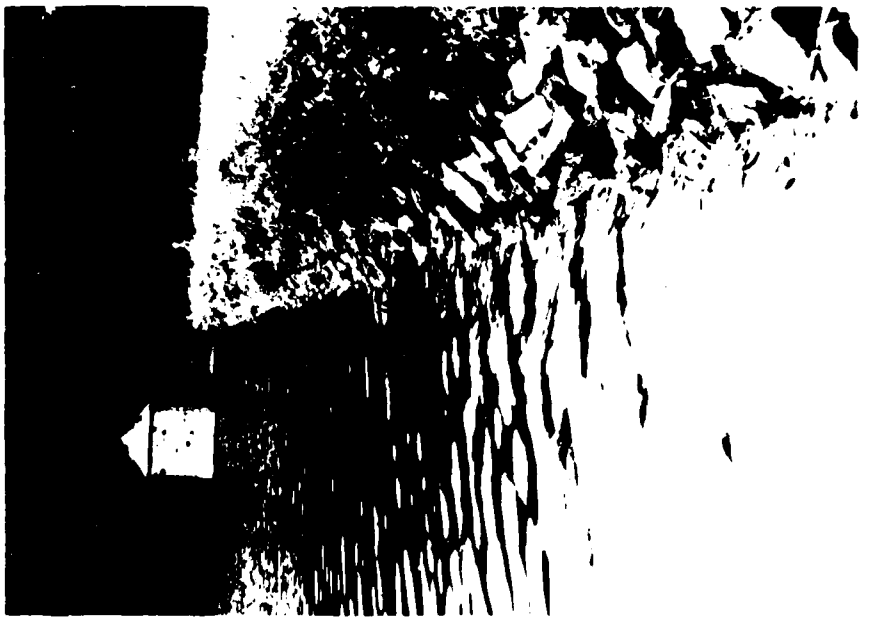


Photo 2 - [illegible] of embankment

US ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS	NATIONAL PROGRAM OF	[illegible]
CAHN ENGINEERS INC. WALLINGFORD, CONN ENGINEER	INSPECTION OF NON-FED. DAMS	[illegible] [illegible] -SYMPAUG BROOK [illegible], CONNECTICUT CE # 27660KC DATE Aug 79 PAGE [illegible]

Photo 3- Left side of downstream slope of dam. Dry-laid stone retaining wall is visible to right of center of photo. Note wet areas above and below retaining wall and trees at left abutment. (Aug 79)

Photo 4 - Stone retaining wall at toe of dam. (Aug 79)

US ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS	NATIONAL PROGRAM OF	CHESTNUT RIDGE RES. DAM
CAHN ENGINEERS INC. WALLINGFORD, CONN ENGINEER	INSPECTION OF NON-FED. DAMS	TR-SYMPAUG BROOK BETHEL, CONNECTICUT CE # 27660KC DATE Aug 79 PAGE C-3

Photo 5- Seepage source at left abutment of dam.(Aug 79)

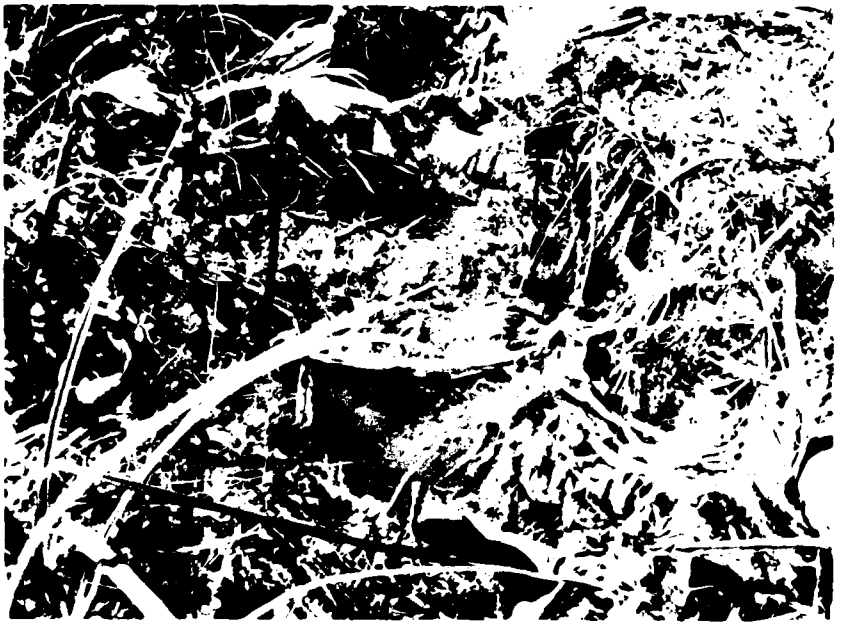


Photo 6 - Seepage stream at left abutment of dam near stone retaining wall. Note brown silt in stream.(Aug 79)

US ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS	NATIONAL PROGRAM OF	CHESTNUT RIDGE DEV. CAM
		TR-SYMPAUG BROOK
		BETHEL, CONNECTICUT
CAHN ENGINEERS INC. WALLINGFORD, CONN. ENGINEER	INSPECTION OF NON-FED. DAMS	CE # 27660KC
		DATE Aug 79 PAGE C-1

Photo 7- Crest of dike and masonry spillway training wall. Note heavy vegetation on dike crest and open joints between stone of the wall. Aug 79

Photo 8 - Upstream slope of dike and spillway from upstream. Note heavy brush and trees. (Aug 79)

US ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS	NATIONAL PROGRAM OF	CHESTNUT RIDGE [illegible] [illegible] SYMPAUG BROOK
CAHN ENGINEERS INC. WALLINGFORD, CONN ENGINEER	INSPECTION OF NON-FED. DAMS	BETHEL, CONNECTICUT CE # 276LORC DATE Aug 79 PAGE C-4

Photo 9 - Spillway approach channel looking [illegible]. Note boulders and brush on channel floor [illegible]

Photo 10-Left side of spillway wall [illegible] Note bulging ground and undermining of masonry [illegible]

US ARMY ENGINEER DIV NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS	NATIONAL PROGRAM OF	[illegible]
CAHN ENGINEERS INC WALLINGFORD, CONN ENGINEER	INSPECTION OF NON-FED. DAMS	CE # DATE [illegible] PAGE

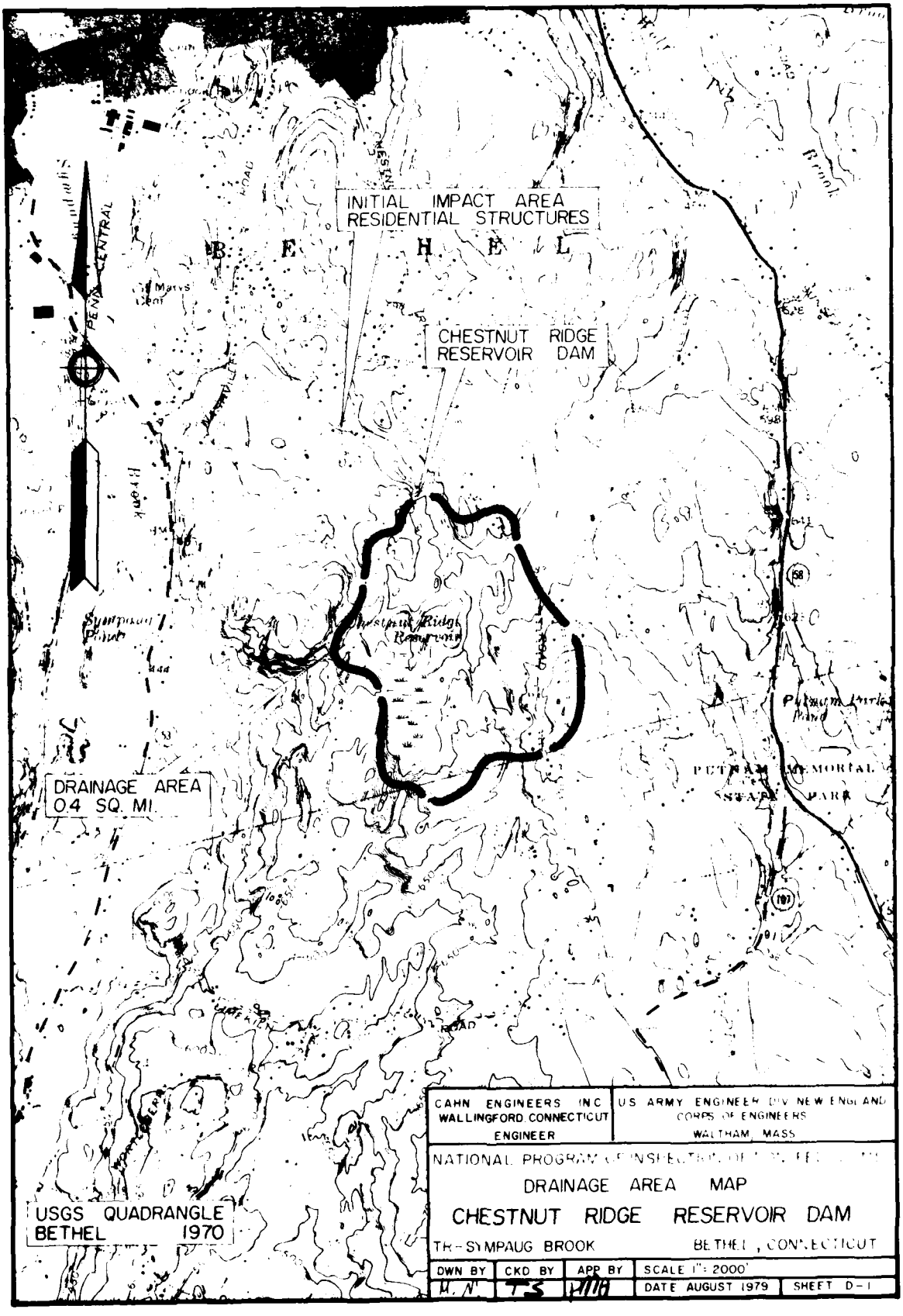
Photo 11 - Spillway discharge channel from upstream. Note [illegible] ruts and trees on channel floor. (Aug 79)

Photo 12 - Gatehouse in reservoir from left abutment of dam. Note valve stand above water surface near gatehouse. (Aug 79)

US ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS	NATIONAL PROGRAM OF	CHESTNUT RIDGE [illegible] TR-SYMPAUG BROOK [illegible] CE # 27660 EC DATE Aug 79 PAGE [illegible]
CAHN ENGINEERS INC. WALLINGFORD, CONN ENGINEER	INSPECTION OF NON-FED. DAMS	

APPENDIX D

HYDRAULICS/HYDROLOGIC COMPUTATIONS


INITIAL IMPACT AREA
RESIDENTIAL STRUCTURES
B E T H E L
CHESTNUT RIDGE
RESERVOIR DAM
DRAINAGE AREA
0.4 SQ. MI.
USGS QUADRANGLE
BETHEL 1970
PUTNAM MEMORIAL
STATE PARK
CAHN ENGINEERS INC
WALLINGFORD CONNECTICUT
ENGINEER
US ARMY ENGINEER DIV NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS
NATIONAL PROGRAM OF INSPECTION OF NON-FEDERAL DAMS
DRAINAGE AREA MAP
CHESTNUT RIDGE RESERVOIR DAM
TR-SYMPAUG BROOK
BETHEL, CONNECTICUT
DWN BY
CKD BY
APP BY
SCALE 1" = 2000'
DATE AUGUST 1979
SHEET D-1

Hydrologic / Hydraulic Inspection
Chestnut Ridge Dam, Bethel, Conn

I) Performance at Test Flood Conditions

1) Probable Maximum Flood

a) Watershed classified as "Rolling"

b) Watershed area = 0.40 sq miles

c) Extrapolating from NED - ACE Guide Curves

PMF = 2600 cfs/sq mile

d) Therefore Peak Inflow:

PMF = 2600 x 0.40 ≈ 1000 cfs

2) Spillway Design Flood (SDF)

a) Classification of Dam

i) Size: Storage ≈ 290* ac feet < 1000 ac feet
Height = 29'** < 40'

* 193 to spillway crest
** field measurement

D-1

2a - Cont'd) Classification

W) Hazard Potential: The dam is immediately upstream of a chlorine house serving Bethel's water supply system & some 1500' upstream of 3 houses 9'-5' above stream bed

JJJ) Size: Small
Hazard: High

b) SDF = PMF = 1000 cfs
½ PMF = 500 cfs

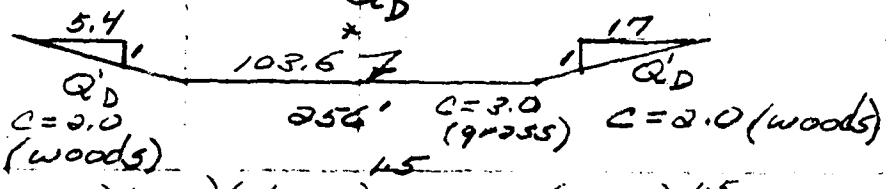
3) Surcharge at Peak Inflows

a) Peak Inflows Q_{p_1} = 1000 cfs

Q'_{p_1} = 500 cfs

b) Outflow Rating Curve for Dam

j) Dam



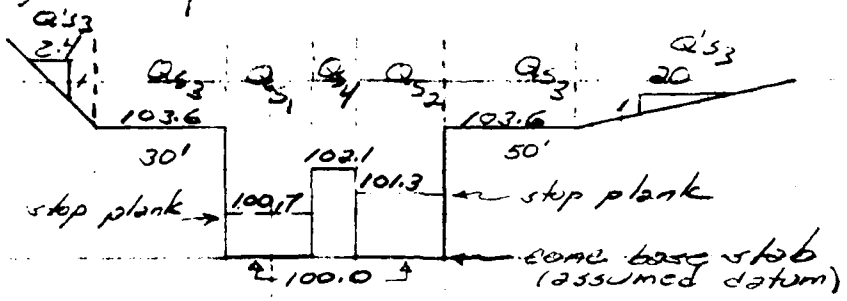
$Q_D = (3.0)(256)(H-2.9) = 768(H-2.9)^{1.5}$

$Q'_D = (2.0)(2/3)(H-2.9)(5.4+17.0)(H-2.9)^{1.5}$
$Q'_D = 29.8(H-2.9)^{2.5}$

* Assumed Datum (conc slab at spillway = 1800)

3b-(continued) Outflow Curve

ii) Spillway



$$Q_{s_1} = (2.8)(11)(H)^{1/2} = 30.8\,H^{1.5}$$

$$Q_{s_2} = (2.8)(11)(H-0.6)^{1/2} = 30.8\,(H-0.6)^{1.5}$$

$$Q_{s_3} = (2.0)(30+50)(H-2.9)^{1.5} = 160\,(H-2.9)^{1.5}$$

$$Q'_{s_3} = (2.0)(2/3)(2.4+20)(H-2.9)(H-2.9)^{1.5} = 29.9\,(H-2.9)^{2.5}$$

$$Q_{s_4} = (2.8)(3)(H-1.4)^{1.5} = 8.4\,(H-1.4)^{1.5}$$

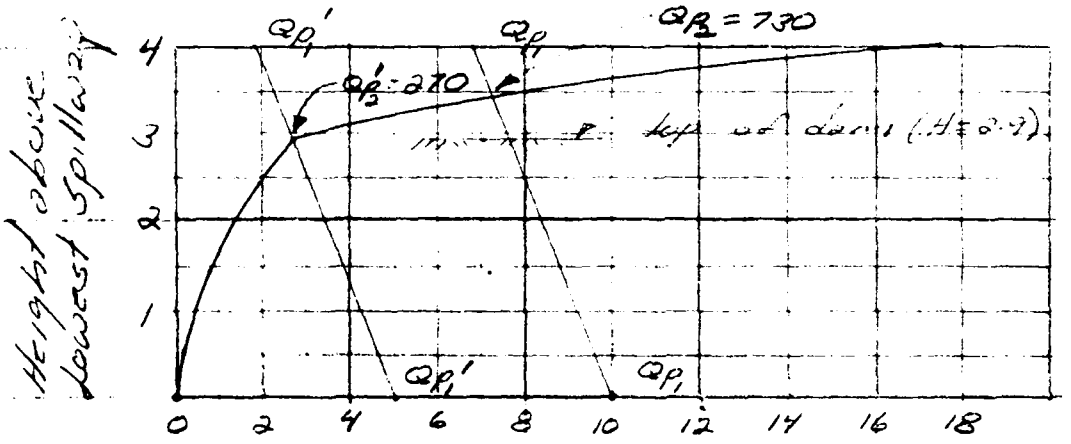
iii) Therefore total outflow can be approximated by the following:

$$Q = 768(H-2.9)^{1.5} + 29.9(H-2.9)^{2.5} + 30.8H^{1.5} + 30.8(H-0.6)^{1.5} + 160(H-2.9)^{1.5} + 29.9(H-2.9)^{2.5} + 8.4(H-1.4)^{1.5}$$

or

$$= 928(H-2.9)^{1.5} + 59.8(H-2.9)^{2.5} + 30.8H^{1.5} + 30.8(H-0.6)^{1.5} + 8.4(H-1.4)^{1.5}$$

3 c) Outflow Rating Curve for Dam & Spillway



d) Surcharge Height to pass Q_{P_1} & Q'_{P_1}

@ $Q_{P_1} = 1000$ cfs $H_1 = 3.6$

$Q'_{P_1} = 500$ cfs $H_1' = 3.2$

e) Spillway capacity to top of Dam (H = 2.9)

= 270 cfs (see sheet 3)

D-4

4) Effect of Storage on Discharges (Outflow)

a) Reservoir area = 32 acres (USGS)

b) Assume normal pool at crest of lowest spillway

c) Watershed area = 0.40 sq miles

d) Discharge (Q_{p_2} & Q'_{p_2}) at various surcharge elevations

H = Height over lowest spillway (100.7)

H = 0; Storage = 0

H = 4; Storage = 4 x 32 = 128 ac.ft.

S = 128/0.40 x 53.3 = 6.0 inches

From $Q_{p_2} = Q_{p_1}(1 - S/19)$

& $Q'_{p_2} = Q_{p_1}(1 - S/4.5)$

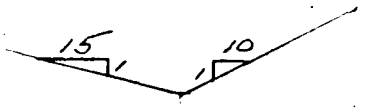
& plots on Rating Curve

Q_{p_3} = 730 cfs ∴ H = 3.4
∴ Dam is overtopped by 0.5'

Q'_{p_3} = 270 cfs ∴ H = 2.9
∴ Ponded pool is just at top of dam

II Downstream Failure Hazard

1) Depth of flow in downstream channel before dam is overtopped:



$S = 1.54\%$
$n = 0.05$

channel section 1500' below Dam at Area of Low Houses (Looking Downstream)

Q (spillway) = 270 cfs (see sheet 4)

Normal depth = 2.3'

2) Peak flood stage at immediate impact area

a) Breach width

i) Mid-height length ≈ 200' (field measurement by Cahn)

ii) Breach width = .4 × 200 = 80' (W_b)

b) Peak failure outflow (assume surcharge to top of dam)

i) Height @ failure = 29' (Y_o)

ii) Spillway discharge = 270 cfs (Q_s)

D-6

2 b-Cont'd) Peak failure outflow

VV) Breach outflow (Q_b)

$$Q_b = 8/27\, w_b \sqrt{g}\, y_0^{3/2} = 21{,}000 \text{ cfs}$$

VV) Peak failure outflow =

$$Q_s + Q_b = 270 + 21{,}000 \approx 21{,}270 \text{ cfs}$$

say 21,300 cfs

c) Increase in normal depth due to dam failure (see section on sheet 6)

Normal depth for 270 cfs = 2.3'

Normal depth for 21,300 cfs = 11.9' (Q_{p_1})

d) Downstream dam failure conditions at impact area

Storage: $S = 390$ ac-ft (see page 1)

Reach length: $L = 1500'$

For $Q_{p_1} = 21{,}300$ cfs ; $y_1 = 11.9'$ Channel $A_1 = 1760$ sq ft

Channel Storage $V_1 = 61$ ac-ft $< \frac{S}{2}$ ok.

$Q_{p_2} = Q_{p_1}\left(1 - \frac{V}{S}\right) = 16{,}800$ cfs ; $y_2 = 10.9$; $A_2 = 1470$ sq ft

$V_2 = 51$ ac-ft ; $\bar{V} = 56$ ac-ft ; $Q_{p_3} = 17200$ cfs (Reach outflow)

Normal depth for 17200 cfs = 11.0' (at impact area)
Increase in normal depth due to failure: $\Delta y = \underline{8.7'}$

PRELIMINARY GUIDANCE

FOR ESTIMATING

MAXIMUM PROBABLE DISCHARGES

IN

PHASE I DAM SAFETY

INVESTIGATIONS

New England Division
Corps of Engineers

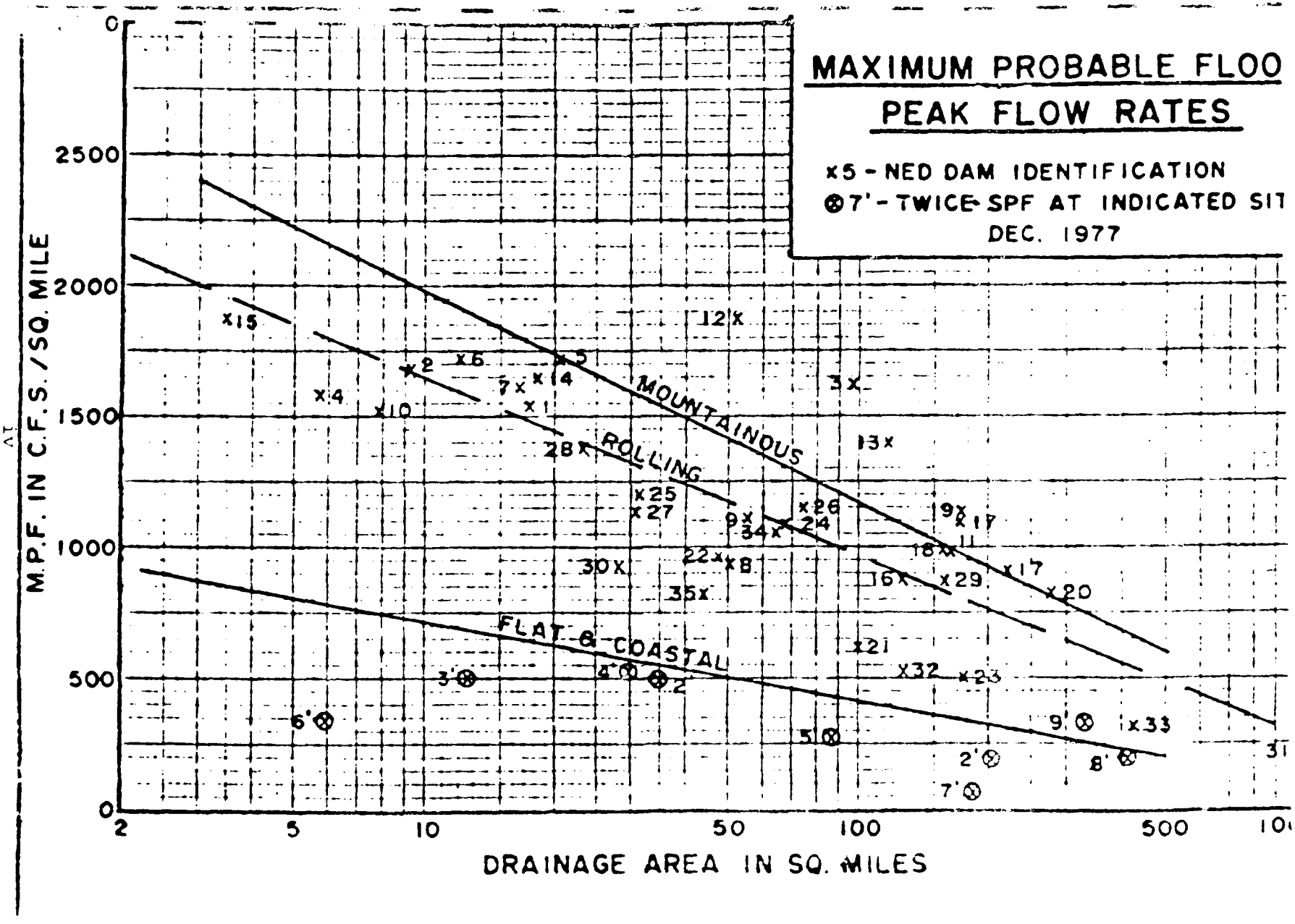
March 1978

MAXIMUM PROBABLE FLOOD INFLOWS
NED RESERVOIRS

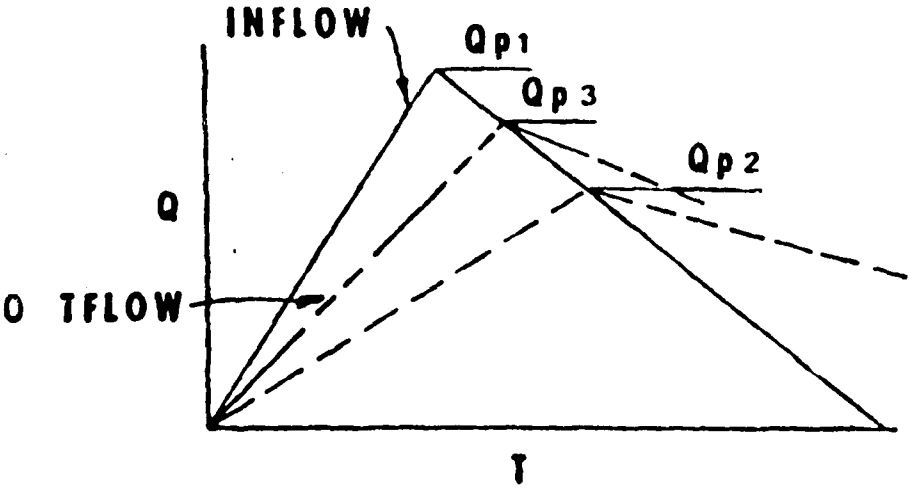
	Project	Q (cfs)	D.A. (sq. mi.)	MPF cfs/sq. mi.
1.	Hall Meadow Brook	26,600	17.2	1,546
2.	East Branch	15,500	9.25	1,675
3.	Thomaston	158,000	97.2	1,625
4.	Northfield Brook	9,000	5.7	1,580
5.	Black Rock	35,000	20.4	1,715
6.	Hancock Brook	20,700	12.0	1,725
7.	Hop Brook	26,400	16.4	1,610
8.	Tully	47,000	50.0	940
9.	Barre Falls	61,000	55.0	1,109
10.	Conant Brook	11,900	7.8	1,525
11.	Knightville	160,000	162.0	987
12.	Littleville	98,000	52.3	1,870
13.	Colebrook River	165,000	118.0	1,400
14.	Mad River	30,000	18.2	1,650
15.	Sucker Brook	6,500	3.43	1,895
16.	Union Village	110,000	126.0	873
17.	North Hartland	199,000	220.0	904
18.	North Springfield	157,000	158.0	994
19.	Ball Mountain	190,000	172.0	1,105
20.	Townshend	228,000	106.0(278 total)	820
21.	Surry Mountain	63,000	100.0	630
22.	Otter Brook	45,000	47.0	957
23.	Birch Hill	88,500	175.0	505
24.	East Brimfield	73,900	67.5	1,095
25.	Westville	38,400	99.5(32 net)	1,200
26.	West Thompson	85,000	173.5(74 net)	1,150
27.	Hodges Village	35,600	31.1	1,145
28.	Buffumville	36,500	26.5	1,377
29.	Mansfield Hollow	125,000	159.0	786
30.	West Hill	26,000	28.0	928
31.	Franklin Falls	210,000	1000.0	210
32.	Blackwater	66,500	128.0	520
33.	Hopkinton	135,000	426.0	316
34.	Everett	68,000	64.0	1,062
35.	MacDowell	36,300	44.0	825

MAXIMUM PROBABLE FLOWS
BASED ON TWICE THE
STANDARD PROJECT FLOOD
(Flat and Coastal Areas)

River	SPF (cfs)	D.A. (sq. mi.)	MPF (cfs/sq. mi.)
1. Pawtuxet River	19,000	200	190
2. Mill River (R.I.)	8,500	34	500
3. Peters River (R.I.)	3,200	13	490
4. Kettle Brook	8,000	30	530
5. Sudbury River.	11,700	86	270
6. Indian Brook (Hopk.)	1,000	5.9	340
7. Charles River.	6,000	184	65
8. Blackstone River.	43,000	416	200
9. Quinebaug River	55,000	331	330


MAXIMUM PROBABLE FLOO
PEAK FLOW RATES
x5 - NED DAM IDENTIFICATION
⊗7' - TWICE SPF AT INDICATED SIT
DEC. 1977
M.P.F. IN C.F.S./SQ. MILE
DRAINAGE AREA IN SQ. MILES
0
500
1000
1500
2000
2500
2
5
10
50
100
500
MOUNTAINOUS
ROLLING
FLAT & COASTAL
x15
x4
x10
x2
x6
x14
x1
x5
12x
3x
13x
28x
x25
x27
x26
24
34x
9x
x17
11
18x
x17
x20
16x
x29
30x
22x
x8
35x
x21
x32
x23
x33
31
3'⊗
4'⊗
2
6'⊗
5⊗
9'⊗
2'⊗
8'⊗
7'⊗

ESTIMATING EFFECT OF SURCHARGE STORAGE ON MAXIMUM PROBABLE DISCHARGES



STEP 1: Determine Peak Inflow (Q_{p1}) from Guide Curves.

STEP 2: a. Determine Surcharge Height To Pass "Q_{p1}".

b. Determine Volume of Surcharge ($STOR_1$) In Inches of Runoff.

c. Maximum Probable Flood Runoff In New England equals Approx. 19", Therefore

$$Q_{p2} = Q_{p1} \times \left(1 - \frac{STOR_1}{19}\right)$$

STEP 3: a. Determine Surcharge Height and "$STOR_2$" To Pass "Q_{p2}"

b. Average "$STOR_1$" and "$STOR_2$" and Determine Average Surcharge and Resulting Peak Outflow "Q_{p3}".

SURCHARGE STORAGE ROUTING SUPPLEMENT

STEP 3: a. Determine Surcharge Height and "$STOR_2$" To Pass "Qp_2"

b. Avg "$STOR_1$" and "$STOR_2$" and Compute "Qp_3".

c. If Surcharge Height for Qp_3 and "$STOR_{AVG}$" agree O.K. If Not:

STEP 4: a. Determine Surcharge Height and "$STOR_3$" To Pass "Qp_3"

b. Avg. "Old $STOR_{AVG}$" and "$STOR_3$" and Compute "Qp_4"

c. Surcharge Height for Qp_4 and "New $STOR_{Avg}$" should Agree closely

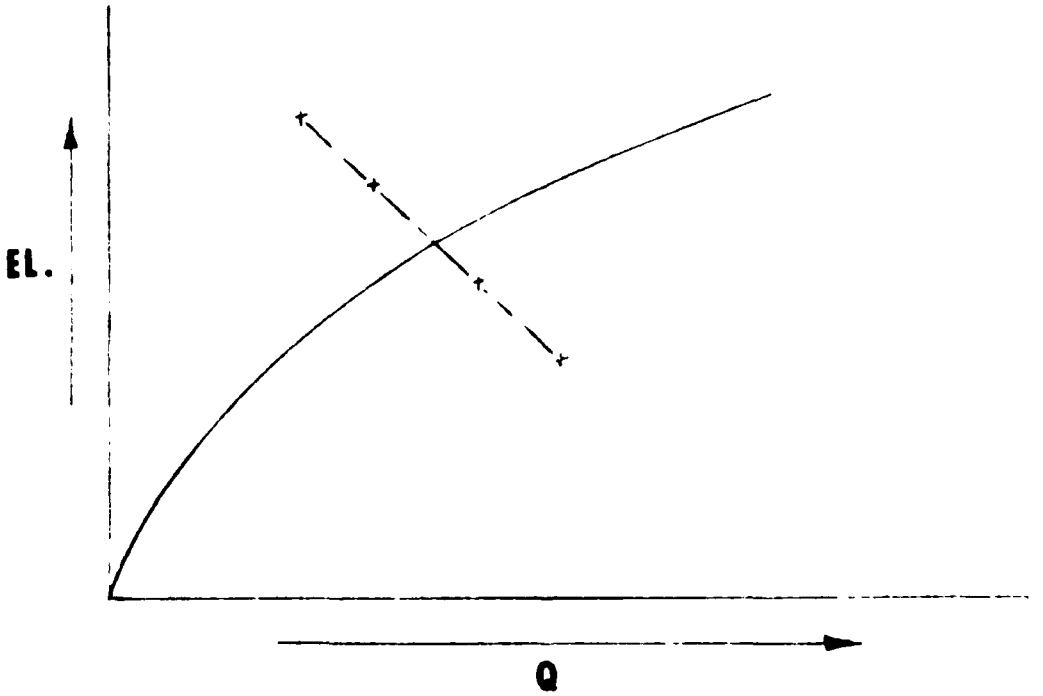
SURCHARGE STORAGE ROUTING ALTERNATE

$$Q_{p2} = Q_{p1} \times \left(1 - \frac{STOR}{19}\right)$$

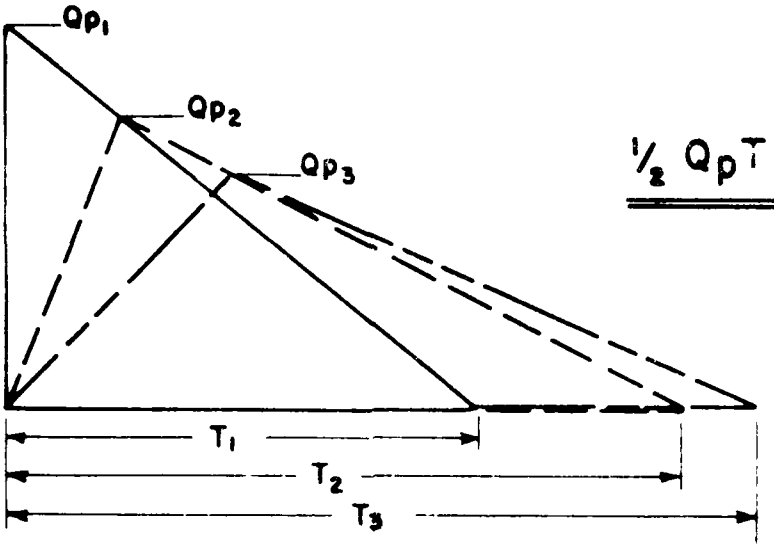
$$Q_{p2} = Q_{p1} - Q_{p1}\left(\frac{STOR}{19}\right)$$

FOR KNOWN Q_{p1} AND 19'' R.O.

Q_{p2}	STOR	EL.
=====	=====	=====



"RULE OF THUMB" GUIDANCE FOR ESTIMATING DOWNSTREAM DAM FAILURE HYDROGRAPHS



$\frac{1}{2} Q_p T = 12 S$

STEP 1: DETERMINE OR ESTIMATE RESERVOIR STORAGE (S) IN AC-FT AT TIME OF FAILURE.

STEP 2: DETERMINE PEAK FAILURE OUTFLOW (Q_{p1}).

$$Qp_1 = \frac{8}{27} W_b \sqrt{g} Y_o^{\frac{3}{2}}$$

W_b = BREACH WIDTH - SUGGEST VALUE NOT GREATER THAN 40% OF DAM LENGTH ACROSS RIVER AT MID HEIGHT.

Y_o = TOTAL HEIGHT FROM RIVER BED TO POOL LEVEL AT FAILURE.

STEP 3: USING USGS TOPO OR OTHER DATA, DEVELOP REPRESENTATIVE STAGE-DISCHARGE RATING FOR SELECTED DOWNSTREAM RIVER REACH.

STEP 4: ESTIMATE REACH OUTFLOW (Q_{p2}) USING FOLLOWING ITERATION.

A. APPLY Q_{p1} TO STAGE RATING, DETERMINE STAGE AND ACCOPMANYING VOLUME (V_1) IN REACH IN AC-FT. (NOTE: IF V_1 EXCEEDS 1/2 OF S, SELECT SHORTER REACH.)

B. DETERMINE TRIAL Q_{p2}.

$$Qp_2(TRIAL) = Qp_1 (1 - \frac{V_1}{S})$$

C. COMPUTE V_2 USING Q_{p2} (TRIAL).

D. AVERAGE V_1 AND V_2 AND COMPUTE Q_{p2}.

$$Qp_2 = Qp_1 (1 - \frac{V_{AVG}}{S})$$

STEP 5: FOR SUCCEEDING REACHES REPEAT STEPS 3 AND 4.

APRIL 1978

APPENDIX E

INFORMATION AS CONTAINED IN THE NATIONAL INVENTORY OF DAMS

INVENTORY OF DAMS IN THE UNITED STATES

(1) STATE	(2) IDENTITY NUMBER	(3) DIVISION	(4) STATE	(5) COUNTY	(6) CONGR DIST.	(7) STATE	(8) COUNTY	(9) CONGR DIST.	(9) NAME	(10) LATITUDE (NORTH)	(11) LONGITUDE (WEST)	(12) REPORT DATE DAY | MO | YR
CT	75	NED	CT	001	05				CHESTNUT RIDGE RESERVOIR DAM	4121.0	7324.1	31AUG79

(13) POPULAR NAME	(14) NAME OF IMPOUNDMENT
BETHEL RESERVOIR DAM	CHESTNUT RIDGE RESERVOIR

(15) REGION	(16) BASIN	(17) RIVER OR STREAM	(18) NEAREST DOWNSTREAM CITY-TOWN-VILLAGE	(19) DIST FROM DAM (MI.)	(20) POPULATION
01	07	TR-SYMPAUG BROOK	BETHEL	2	11100

(21) TYPE OF DAM	(22) YEAR COMPLETED	(23) PURPOSES	(24) STRUCTURAL HEIGHT (FT.)	(25) HYDRAULIC HEIGHT (FT.)	(26) IMPOUNDING CAPACITIES MAXIMUM (ACRE-FT.)	(27) NORMAL (ACRE-FT.)	DIST	OWN	FED R	PRV/FED	SCS A	VER/DATE
REPG	1910	S	29	29	290	193	NED	N	N	N	N	

(28) REMARKS
20-ESTIMATE

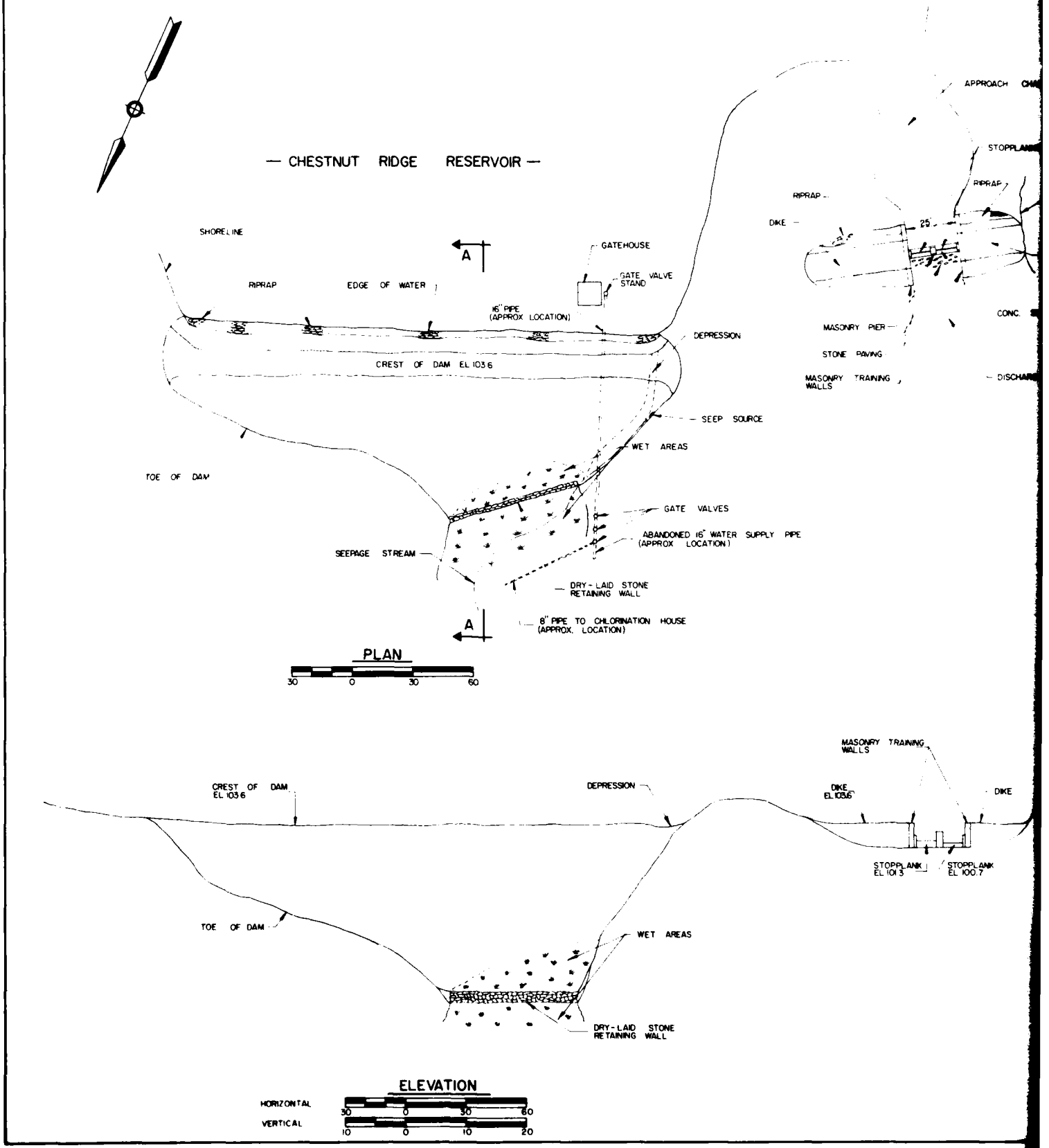
(29) O/S HAS	(30) SPILLWAY CREST LENGTH	(31) TYPE	(32) WIDTH (FT.)	(33) MAXIMUM DISCHARGE (FT.)	(34) VOLUME OF DAM (CY)	(35) POWER CAPACITY INSTALLED (MW)	(36) PROPOSED (MW)	(37) NO	(38) NAVIGATION LOCKS LENGTH (FT.)	(39) WIDTH (FT.)	(40) LENGTH (FT.)	(41) WIDTH (FT.)	(42) LENGTH (FT.)	(43) WIDTH (FT.)	(44) LENGTH (FT.)	(45) WIDTH (FT.)
1	366	U	22	270												

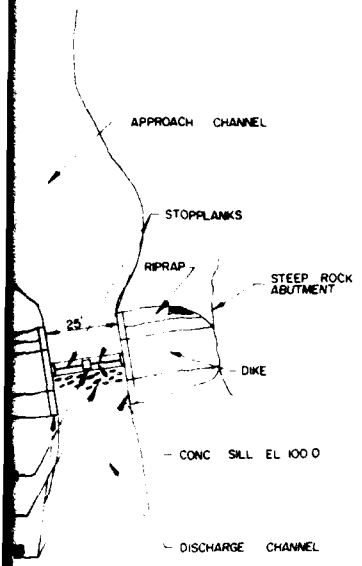
(46) OWNER	(47) ENGINEERING BY	(48) CONSTRUCTION BY
TOWN OF BETHEL	UNKNOWN	J BOAS

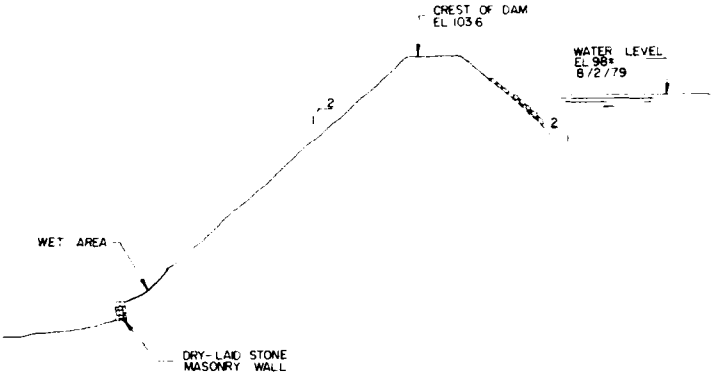
(49) REGULATORY AGENCY DESIGN	CONSTRUCTION	OPERATION	MAINTENANCE
CT WATER RESOURCES	CT WATER RESOURCES	CT WATER RESOURCES	CT WATER RESOURCES

(50) INSPECTION BY	(51) INSPECTION DATE DAY | MO | YR	(52) AUTHORITY FOR INSPECTION
CAHN ENGINEERS INC	02AUG79	PL 92-367

(53) REMARKS
30-DAM PLUS DIKE


— CHESTNUT RIDGE RESERVOIR —
SHORELINE
A
GATEHOUSE
GATE VALVE STAND
RIPRAP
EDGE OF WATER
16" PIPE (APPROX LOCATION)
DEPRESSION
CREST OF DAM EL 1036
SEEP SOURCE
WET AREAS
TOE OF DAM
GATE VALVES
ABANDONED 16" WATER SUPPLY PIPE (APPROX LOCATION)
SEEPAGE STREAM
DRY-LAID STONE RETAINING WALL
8" PIPE TO CHLORINATION HOUSE (APPROX. LOCATION)
PLAN
30 0 30 60
APPROACH CHA
STOPPLA
RIPRAP
RIPRAP
DIKE
25'
CONC.
MASONRY PIER
STONE PAVING
MASONRY TRAINING WALLS
DISCHARG
MASONRY TRAINING WALLS
CREST OF DAM EL 1036
DEPRESSION
DIKE EL 1036
DIKE
STOPPLANK EL 101.3
STOPPLANK EL 100.7
TOE OF DAM
WET AREAS
DRY-LAID STONE RETAINING WALL
ELEVATION
HORIZONTAL
VERTICAL
30 0 30 60
10 0 10 20





SECTION A-A

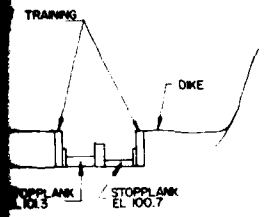
HORIZONTAL 20 0 20 40

VERTICAL 10 0 10 20

NOTES

1 THIS PLAN WAS COMPILED FROM A CAHN ENGINEERS PRELIMINARY SURVEY OF THE DAM DATED AUGUST 2, 1979. DIMENSIONS SHOWN ARE APPROXIMATE NOT ALL TOPOGRAPHIC AND/OR STRUCTURAL FEATURES ARE NECESSARILY IDENTIFIED

2 NO ELEVATIONS WERE AVAILABLE FOR THE DAM AND NO WATER SURFACE ELEVATION FOR THE RESERVOIR IS SHOWN ON THE USGS BETHEL QUADRANGLE MAP THEREFORE ALL ELEVATIONS SHOWN ARE REFERENCED TO A BENCH MARK OF 100 SET AT THE CONCRETE SPILLWAY SILL



CAHN ENGINEERS INC WALLINGFORD, CONNECTICUT ENGINEER	U S ARMY ENGINEER DIV NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS

NATIONAL PROGRAM OF INSPECTION OF NON-FED DAMS

PLAN, ELEVATION & SECTION

CHESTNUT RIDGE RESERVOIR DAM

TR-SYMPAUG BROOK BETHEL, CONNECTICUT

DRAWN BY	CHECKED BY	APPROVED BY	SCALE AS NOTED	
MN	TS	PmH	DATE AUGUST 1979	SHEET 8-1


ATE
LME